

**ATTACHMENT H-2**

**GEOCHEMICAL CHARACTERIZATION OF IN SITU RECOVERY  
PROCESS SOLUTIONS, DUKE HYDROCHEM LLC**



## **REPORT**

# **GEOCHEMICAL CHARACTERIZATION OF IN SITU RECOVERY PROCESS SOLUTIONS**

### **PREPARED FOR:**

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## 1.0 Executive Summary

1. Excelsior Mining Corp (Excelsior) is proposing to develop the Gunnison Copper Project utilizing in situ recovery (ISR) methods.
2. Work presented in this report has been conducted in support of Excelsior's applications for an Aquifer Protection Permit (APP) from the Arizona Department of Environmental Quality (ADEQ) and an Underground Injection Control (UIC) permit from the U.S. Environmental Protection Agency (EPA).
3. This report summarizes Project geology, geochemistry, and hydrogeology and results of chemical reaction modeling to provide the following:
  - a. Estimated/forecast compositions of ISR fluids
  - b. Estimated operational parameters associated with the proposed closure strategy including required rinsing volumes and resting times
  - c. Estimated chemical composition of the fluid resident in the ore body after rinsing
  - d. Modeled geochemical behavior of PLS should it be released to non-mineralized carbonate units adjacent to the ore body under upset conditions (i.e. loss of hydraulic control)
4. The current closure strategy incorporates the following elements:
  - a. Once ISR is complete, the ore block will be rinsed with groundwater from the Gunnison site until a mixture of approximately 95 percent groundwater and 5 percent PLS is attained
  - b. After the initial rinsing, the PLS/groundwater mixture will be maintained in the subsurface in contact with the post-leach mineral assemblage until circumneutral pH conditions are attained
  - c. After the resting period further rinsing will be conducted until concentrations of all regulated constituents are below Arizona Aquifer Water Quality Standards (AWQS)
  - d. Hydraulic control will be maintained throughout the post-ISR rinsing and resting periods
5. Integration of geochemical modeling results with rinsing data from rinse tests provides the following understanding of the geochemical behavior of solutions associated with the rinse-rest-rinse closure scenario:
  - a. Based on rinse testing data it is anticipated that a mixture of 95 percent groundwater and 5 percent PLS is attained after rinsing approximately three pore volumes
  - b. The PLS/groundwater mixture reaches circumneutral pH after being maintained in the subsurface for approximately 100 – 200 days depending on the geologic unit hosting the fluid

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- c. Once circumneutral conditions are attained in the resting solution, concentrations of all regulated constituents fall below Aquifer Water Quality Standards (AWQS) with the exception of fluoride which is present at 6 milligrams per liter (mg/L) (AWQS = 4 mg/L)
    - d. After a modeled rest period of one year, two additional pore volumes of rinsing are required to further decrease concentrations of any residual regulated constituents. This includes fluoride which is reduced to background concentration of approximately 3 mg/L and sulfate which is controlled by the solubility of gypsum.
  6. Results of geochemical modeling provide the following understanding of the geochemical behavior of PLS should it be released to Paleozoic limestone units adjacent to the orebody as the result of upset conditions (i.e., loss of hydraulic control):
    - a. PLS is neutralized very quickly; modeled pH becomes circumneutral in approximately one day
    - b. Once the PLS is neutralized all regulated constituents are below AWQS with the exception of cadmium (0.4 mg/L compared with AWQS of 0.005 mg/L) and selenium (at the AWQS of 0.05 mg/L). In addition, uranium concentrations remain somewhat elevated at 0.4 mg/L which is above the U.S. EPA maximum contaminant level (MCL) of 0.03 mg/L.
    - c. Sulfate concentration is controlled by the solubility of gypsum.

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## 2.0 Introduction

Excelsior Mining Corp (Excelsior) is proposing to develop the Gunnison Copper Project utilizing in situ recovery (ISR) methods to produce copper from the Gunnison Project ore deposit. Excelsior has conducted a series of intensive investigations into the geology, geochemistry, and hydrogeology of the Gunnison Project site. At the request of Excelsior, Duke HydroChem, LLC (DHC) has integrated the results of these investigations to develop a series of geochemical models in order to: 1) provide estimates of the in situ recovery solution compositions; 2) assess the proposed closure strategy; and, 3) simulate the results of potential upset conditions under which hydraulic control may be lost. Geochemical modeling provides chemical loading source terms to be integrated with Excelsior's 3-D groundwater flow-and-transport model to predict groundwater quality at point-of-compliance (POC) wells post-closure as well as during and after potential upset conditions. This work has been conducted in support of Excelsior's applications for an Aquifer Protection Permit (APP) from the Arizona Department of Environmental Quality (ADEQ) and an Underground Injection Control (UIC) permit from the U.S. Environmental Protection Agency (EPA).

Objectives of this study include:

- Provide estimated/forecast compositions of ISR fluids including:
  - Makeup water (groundwater from within or adjacent to the Project site)
  - Sulfuric acid used to make leach solutions
  - Barren leach solution or sulfuric acid leach solution (lixiviant)
  - Pregnant leach solution (PLS)
- Estimate operational parameters associated with the proposed closure scenario including required rinsing volumes and resting times
- Estimate the post-closure chemical composition of the fluid resident in the ore body
- Assess the likely geochemical processes and behavior of PLS should it be released to non-mineralized limestone units adjacent to the ore body under upset conditions (i.e. loss of hydraulic control).

### 2.1 Geologic Setting and Mineralization

The Gunnison Project is located approximately 65 miles southeast of Tucson in the Johnson Camp Mining District, Cochise County, Arizona. The Project site lies on the eastern edge of the Little Dragoon Mountains in an area dominated by Precambrian Pinal Group schists and Paleozoic sediments to the north and Tertiary Texas Canyon Quartz Monzonite to the south. The Paleozoic units host the regional copper mineralization. Detailed discussion of the regional

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geology and Gunnison Project ore mineralization are available elsewhere (Cooper and Silver, 1964; M3, 2014); however, a brief summary is provided in the following sections.

### **2.1.1 Regional Geology**

The Gunnison Project is located in the Mexican Highland section of the Basin and Range province. The age of rocks ranges from recent Holocene sediments to approximately 1.4 billion year old Pinal Group schists. In the Gunnison Project area the units include:

- Upper Tertiary and Quaternary basin fill
- Tertiary Texas Canyon Quartz Monzonite
- Middle Pennsylvanian Horquilla Limestone
- Lower Pennsylvanian Black Prince Limestone
- Lower Mississippian Escabrosa Limestone
- Upper Devonian Martin Formation
- Upper Cambrian Abrigo Formation
- Middle Cambrian Bolsa Quartzite
- Upper Precambrian Apache Group (Pioneer Shale)
- Lower Precambrian Pinal Schist Group

Principal periods of structural deformation in the area include:

- Pre-Apache Group deformation of the Pinal Schist Group that gave rise to a general northeastern structural trend
- Post-Paleozoic/pre-Cretaceous deformation that resulted in steep northeast to easterly striking faults with offsets on the order of hundreds of feet
- The Laramide Orogeny which was associated with regional mineralization and ore-body formation
- Basin and Range deformation which formed the current regional topography

### **2.2.1 Gunnison Project Ore Mineralization**

The oxidized portion of the Gunnison Project ore deposit is hosted in Paleozoic sedimentary units, primarily the Martin and Abrigo Formations and to a lesser extent the Horquilla Limestone and the lower Escabrosa Limestone (M3, 2014). Copper mineralization is associated with calc-silicate skarns formed when the Tertiary Texas Canyon Quartz Monzonite intruded the carbonate rocks resulting in the following alteration assemblages:

- Martin Formation: grades from a wollastonite-diopside-forsterite dominated assemblage near the porphyry to a distal diopside-tremolite-actinolite assemblage



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- Abrigo Formation: garnet-actinolite-epidote-diopside alteration with some biotite hornfels near the porphyry grading to distal tremolite alteration

Copper oxide mineralization consists primarily of the hydrated copper silicate chrysocolla ( $\text{CuSiO}_3 \cdot \text{H}_2\text{O}$ ) which is present as coatings on rock fractures and as vein fill.

## 2.2 In Situ Copper Recovery

In situ recovery (ISR) is a mining process in which a leach solution, or lixiviant, is circulated through an ore body utilizing a network of injection and recovery wells in order to leach and recover economic elements from the ore. ISR is widely utilized in the beneficiation of uranium as well as other non-ferrous metals and soluble salts such as halite, trona, and potash (Bartlett, 1992). At the Gunnison Project, a sulfuric acid leach solution (lixiviant) will be used to extract copper from oxide mineralization within the ore deposit. The lixiviant loaded with dissolved copper, known as pregnant leach solution (PLS), will be processed using solvent extraction (SX) and electrowinning (EW); once the copper has been recovered the raffinate (PLS without the copper) will be re-acidified, and re-injected as barren leach solution. Excelsior proposes to develop the Gunnison Project in several phases; each phase will consist of a portion of the ore deposit (a “block”) in which a network of injection and recovery wells has been completed. Once a block has been leached and is no longer producing economic quantities of copper, active leaching will cease and the closure strategy will be applied to the leached block until the resident fluid composition meets applicable groundwater quality standards.

## 2.3 Geochemical Modeling Approach

Geochemical modeling was implemented in the REACT module of the geochemical modeling software The Geochemist’s Workbench (GWB), release 10.0 (Bethke and Yeakel, 2014). The thermodynamic database “thermo.com.V8.R6+”, developed at Lawrence Livermore National Laboratory, was used for all geochemical equilibrium calculations. Selected secondary phases were allowed to precipitate at a saturation index of zero (i.e. as soon as the phase reached saturation) to control solubility of key chemical constituents. Secondary phases that might reasonably be expected to form under the pH and temperature conditions of the ISR operations without substantial kinetic barriers were chosen consistent with guidance in Alpers et al. (1994), Nordstrom and Alpers (1999), and Jansen and Taylor (2003).

Geochemical modeling of the closure strategy required that a kinetic approach be applied to the resting portion of the model in order to estimate the time required for neutralization reactions to bring the pH of the solution to circumneutral conditions. For this model, in addition to the equilibrium thermodynamic data discussed above, a series of kinetic rate laws were applied to simulate the dissolution of silicate and aluminosilicate mineral phases. To the

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extent possible, kinetic rate laws were selected that were representative of mineral dissolution rates at pH, temperature, and ionic strength conditions similar to conditions anticipated in the ore body during the resting period. The majority of rate laws were taken from a compilation provided in Brantley et al. (2008); however, gypsum and chlorite were not included in Brantley et al. (2008) so kinetic rate laws were selected from (Jeschke et al., 2001) and (Brandt et al., 2003) for gypsum and chlorite, respectively. In addition, surface complexation on hydrous ferric oxides (HFO) was included in the resting portion of the model using the surface database “FeOx+.dat” (Dzombak and Morel; 1990) amended to include thallium complexation (Lin and Nriagu, 1998).

Further details regarding input data and assumptions for the specific models are provided in **Sections 3.0 through 5.0** below.

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## 3.0 In Situ Recovery Solution Characterization

This section provides a brief description of each of the principal ISR solutions and an explanation of the process by which an estimated chemical composition of each has been derived. Forecast compositions are summarized in **Table 1** for the following ISR solutions:

- Makeup water (groundwater from within or adjacent to the Project site)
- Sulfuric acid used to make lixiviant
- Barren leach solution (lixiviant)
- Pregnant leach solution (leach solution loaded with copper)

Fluid compositions are provided for a suite of chemical species that include:

- Constituents with Arizona Aquifer Water Quality Standards (AWQS)
- Constituents listed in the ADEQ Arizona Mining Guidance Manual BADCT (ADEQ, 2004) Appendix B, Part C including:
  - Metals
  - Major cations and anions
  - Physical parameters

Concentrations of all estimated and forecast fluids are reported to one significant figure (**Table 1**) in order to acknowledge potential variability in fluid compositions and account for uncertainty in laboratory analytical data.

### 3.1 Makeup Water

Makeup water will be drawn from water supply wells that will be installed in basin fill at or near the Gunnison site. The estimated concentrations provided in **Table 1** are based on data from a sample collected on 13 May 2015 from Excelsior hydrology test well NSH-006 and are deemed representative of the likely chemical composition of makeup water. Well NSH-006 is screened between 640 and 680 feet below land surface (ft bls) in basin fill. For further details on Gunnison site groundwater composition see Attachment I of this UIC application. Laboratory reports are provided in **Exhibit 1A**. Water quality parameters measured during a pumping test conducted at well NSH-006 are provided in **Exhibit 1B**.

### 3.2 Sulfuric Acid

A range of potential sulfuric acid compositions is provided in **Table 1**. These ranges are based on chemical analyses for technical grade sulfuric acid (93.0 - 98.5 percent) provided by ASARCO LLC of Tucson, Arizona, and SA Services LLC of Houston, Texas. It should be recognized that the

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grade (strength) and composition of sulfuric acid will vary over the life of the project as suppliers and sources change. However, ASARCO produces sulfuric acid at their smelter in Hayden, Arizona, and SA Services provides sulfuric acid from a range of sources including the Arizona smelters therefore the data are deemed representative of the likely composition of locally derived sulfuric acid. Analytical chemistry data supplied by ASARCO and SA Services are provided in **Exhibit 2** (note units of milligrams per kilogram (mg/kg)).

### **3.3 Barren Leach Solution**

In ISR, barren leach solution is the solution injected into the ore body in order to leach copper from the ore minerals. The solution used to leach the Gunnison Project ore will initially consist of local groundwater acidified with technical grade sulfuric acid. As the leach solution is circulated through the ore body it will interact with both copper (ore) minerals and a range of gangue (non-economic) minerals. When the leach solution is loaded with dissolved copper it is called pregnant leach solution (PLS). The copper is removed from the PLS every leach cycle in the SX/EW plant and the resulting solution is called raffinate which is re-acidified to make barren leach solution. Although copper is recovered from the PLS with each leach cycle, non-economic constituents contributed by the gangue minerals are not removed. The combination of mineral dissolution and the continued addition of sulfuric acid with each leach cycle results in a highly concentrated solution that, once it approaches equilibrium with the system, is referred to as being 'mature'. The composition of the mature barren leach solution is reasonably consistent with time because the dissolution and precipitation reactions that control the composition approach equilibrium and no longer cause substantial changes in the leach solution chemical load.

#### **3.3.1 Johnson Camp Raffinate**

Because the Gunnison Project is not yet operational, it is not possible to analyze actual barren leach solution. Instead, the estimated composition of the Gunnison barren leach solution is based on analysis of mature raffinate from an adjacent mine at Johnson Camp. Raffinate is the term applied to the PLS after it has been through the SX/EW plant and the copper has been removed. When raffinate is re-acidified and ready to be re-injected into the ore body, it is barren leach solution. Therefore the chemical load in the raffinate is very similar to that in the barren leach solution with the only major difference being the free acid concentration which is higher in the barren leach solution.

Johnson Camp Mine is located approximately one mile to the northwest of the Gunnison Project site. The primary ore body mined at Johnson Camp is the Burro copper oxide body (mined from the Burro Pit). The Burro orebody is hosted in the Lower Abrigo formation, one of

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the Paleozoic sedimentary formations that also host the Gunnison Project ore deposit (Bikerman Engineering, 2007). Copper is present as oxide minerals (predominantly chrysocolla and malachite) that formed primarily along fractures and on bedding planes. As such, both the host rock and the mineralized orebody present at Johnson Camp are very similar to those at the Gunnison site. In addition, the mining method, although it is not in situ, is similar to that proposed for the Gunnison Project in that copper minerals are leached using a sulfuric acid lixiviant.

The use of chemistry data from existing similar operations is provided as a suggested approach to solution characterization in the ADEQ Arizona Mining Guidance Manual BADCT, Section 3.4.3 (ADEQ, 2004). The similarities in host rock chemistry, ore mineralization, and leaching process between Johnson Camp and the Gunnison Project indicate that mature raffinate sampled from the leaching operation at Johnson Camp is a reasonable analog for the composition of mature Gunnison Project barren leach solution.

### 3.3.2 Chemical Composition of Barren Leach Solution

The estimated chemical composition of Gunnison barren leach solution based on Johnson Camp raffinate is presented in **Table 1**. It should be noted that the chemical composition of the barren leach solution will evolve over the life of the mine from acidified groundwater to the mature composition reported in **Table 1**. For all analytes except fluoride, iron, and copper, data presented in **Table 1** are based the laboratory reports for Johnson Camp raffinate provided in **Exhibit 3**. Concentrations in the modeled barren leach solution (and in all forecast solutions) are reported to one significant figure. When modeled concentrations fall below the reporting limit (RL) provided by the applicable laboratory (**Exhibit 3**) they are reported as <RL.

Anticipated fluoride, iron, and copper concentrations in the Gunnison Project raffinate are different from the laboratory reports for the reasons presented below:

- Fluoride concentration reported by the laboratory (ALS Environmental-Kelso) contains a potential low bias due to suspected matrix interference. In order to recognize the potential for higher fluoride concentrations in the Johnson Camp raffinate (and in the Gunnison leaching solutions) an estimated range of potential fluoride concentrations is presented in **Table 1**. The low end of the range is the analytical value provided by ALS Environmental-Kelso. The high end of the range is based on fluoride levels up to 1,200 milligrams per liter (mg/L) reported in Johnson Camp wells (Dickens, 2003).
- Iron concentration of 135 mg/L is reported by the laboratory (SGS Tucson) for Johnson Camp raffinate. However, based on results of Excelsior's metallurgical testing of Gunnison Project ore, iron concentrations are anticipated to be higher than those observed in the Johnson Camp raffinate. In order to more accurately represent the

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likely iron concentration in the Gunnison leach solutions, an iron concentration of 1,000 mg/L is provided in **Table 1** and used in subsequent geochemical modeling.

- Copper concentration in the barren leach solution is a function of the copper grade of the PLS and the efficiency of the SX/EW. At an anticipated average operational PLS grade of 1.5 g/L and standard SX/EW efficiency of 90 percent, the copper concentration of the barren leach solution would be 150 mg/L as reported in **Table 1**. PLS copper grade may vary from approximately 0.2 to 5 g/L and the copper concentration in the barren leach solution would accordingly range between 20 and 500 mg/L.

It should be noted that the free acid content (and therefore the pH) of the barren leach solution will be adjusted prior to solution re-injection by addition of technical grade sulfuric acid. Therefore, the final acid concentration (and pH) of the solution will vary according to operational requirements. Excelsior anticipates that the operational free acid content of the barren leach solution will be in the range of 5 to 15 grams per liter (g/L); however, it may be necessary, should the Project encounter a highly acid-consuming area of ore, to raise the free acid concentration in the barren leach solution as high as 50 g/L for short periods of time. In order to calculate the pH of the barren leach solution at both the standard operational acid range and at potential maximum acid concentrations, geochemical equilibrium modeling was conducted in the REACT module of GWB. Equilibration of the barren leach solution chemistry with free acid concentrations of 5 g/L and 15 g/L provides an estimated operational pH range of 1.8 to 1.3. Barren leach solution brought up to a free acid concentration of 50 g/L gives a computed pH value of 0.6. The potential pH range of the barren leach solution is provided in **Table 1**.

### 3.4 Pregnant Leach Solution

Pregnant leach solution (PLS) is composed of the same constituents as barren leach solution plus dissolved copper. The amount of copper contained in the mature PLS is a function not only of the availability of the copper-bearing minerals, but also of several operational parameters including the acidity of the leach solution and the residence time of the leach solution in the ore body. These operational parameters will be adjusted during mining to maintain the PLS at the required operational copper grade. Anticipated average operational copper grade of the Gunnison PLS is approximately 1.5 g/L (M3, 2014).

The acidity of the PLS changes with time due to variation in both copper recovery and acid-consuming properties of the ore with leaching. Based on intensive metallurgical testing, Excelsior reports that cumulative net acid consumption will average about 8.1 lb/lb Cu over the life of the mine (M3, 2014).

An average PLS composition was computed by reacting the injected leach solution (assuming initial free acid content of 15 g/L) with chrysocolla and calcite in the GWB module REACT to

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simulate leaching of acid soluble copper and associated acid-consuming gangue minerals. Chrysocolla was allowed to leach until the anticipated operational copper grade of approximately 1.5 g/L was attained. Calcite ( $\text{CaCO}_3$ ) addition was scaled to represent the acid consumption levels reported by Excelsior. The only secondary mineral precipitated in the PLS model was gypsum which controls calcium concentration (and contributes to changes in sulfate concentration though the dominant source of sulfate in the PLS is addition of sulfuric acid). Two end-member models were run to assess the impact of the range of reported acid consumptions (4.5 to 8.1 lb/lb Cu). The modeled PLS solutions have pH values of 1.6 to 2.1 for acid consumptions of 4.5 and 8.1 lb/lb Cu, respectively. The chemical compositions of the two end-member modeled PLSs are essentially the same and are reported in **Table 1**. Concentrations in the modeled PLSs are reported to one significant figure with the exception of copper which is reported at the anticipated operational grade of 1.5 g/L. When modeled concentrations fall below the reporting limit (RL) provided by the applicable laboratory (**Exhibit 3**) they are reported as <RL.

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## 4.0 Wellfield Closure

Once copper recoveries drop below the economic cutoff, ISR in a given production block will be deemed complete, and the closure strategy will be applied to the block until applicable water quality standards are met. The current conceptual model for closing a portion of the wellfield includes the following elements:

- The portion of the orebody to be closed will be rinsed with makeup water (Gunnison site groundwater) by injecting rinse fluid via injection wells and extracting the rinsate via recovery wells
- Rinsing will continue until fluid resident in the ore body is approximately 95 percent groundwater and 5 percent pregnant leach solution (PLS). It is anticipated that this will require an initial flush of approximately three pore volumes; this estimate is based on rinsing of leached ore from metallurgical tests (see Attachment H-3 of this UIC application).
- After initial rinsing, the 95 percent groundwater/5 percent PLS solution will be allowed to rest in the subsurface in contact with the post-leaching mineral assemblage; hydraulic containment will be maintained
- Neutralization of the solution will occur as silicate minerals and residual carbonate minerals are altered; solute concentrations will be controlled by precipitation of secondary minerals and complexation (sorption) on hydrous ferric oxide surfaces
- The resting period will continue until pH of the resident solution is circumneutral and the majority of the regulated constituents are below applicable groundwater standards. Based on geochemical modeling results presented below it is recommended that resting conditions be maintained for approximately one year
- A final rinse of two pore volumes will be conducted in order to facilitate removal of any constituents that might still be present above regulatory limits
- Sampling of rinsate will be conducted during post-rest rinsing in order to confirm that concentrations of regulated constituents meet AWQS prior to initiating closure

The following sections provide details regarding geochemical modeling of each phase of the closure scenario together with supporting data and analysis.

### 4.1 Initial Rinse Period

Geochemical modeling of fluid compositions (rinsate) after the initial rinse period was conducted by simulating a mixture of 5 percent PLS and 95 percent makeup water (groundwater) in equilibrium with gypsum. PLS and makeup water compositions are presented in **Table 1** and discussed in **Section 3.0** above. Analysis of rinsing data from Excelsior's metallurgical testing program indicates that dilution of PLS to 5 percent will require



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approximately three pore volumes of rinsing (see Attachment H-3 of this UIC application). The modeled composition of the fluid in the ore block after the initial rinsing was used as input to the resting models described in **Section 4.2** below.

## **4.2 Resting Period**

During the resting period the dilute groundwater/PLS mixture will be maintained in contact with minerals remaining in the ore block at the end of active ISR. This mineral assemblage is composed of silicate and iron oxy-hydroxide minerals and gypsum as described in **Section 4.2.3** below. The modeled pH of the groundwater/PLS mixture at the beginning of the resting period is 2.7. As the silicate minerals alter they neutralize the residual acidity in the solution and the pH rises. Although acid neutralization by silicate minerals is relatively slow compared to neutralization by Ca- and Mg-carbonates, buffering of acidic mine solutions at neutral pH has been observed in systems in which acid generation rates and flushing rates are very low (INAP, 2009; Jambor, 2003). The resting period between episodes of rinsing provides ideal conditions for neutralization by silicate minerals in that: 1) acidity of the dilute groundwater/PLS mixture is relatively low (model results indicate free acid on the order of 250 mg/L); 2) once the rest period begins there is little or no ongoing acid generation; 3) there is little or no flow through the resting portion of the ore body so fluid remains in contact with the altering mineral phases and is not replaced by solution flowing into the ore block and bringing new loads of acidity; and, 4) there is almost unlimited availability of silicate minerals including those that are reasonably fast-acting such as Ca-rich feldspars, olivine, hornblende, and chlorite.

As shown in **Figure 1**, model results indicate that circumneutral pH conditions (i.e., pH ~ 7) are reached in approximately 100 to 200 days, depending on the geologic unit hosting the solution. As the pH rises, secondary minerals precipitate and trace elements are sorbed to oxy-hydroxide surfaces. By the time the resting solution reaches circumneutral pH all regulated constituents are below Arizona AWQS with the exception of fluoride which is present at approximately 6 mg/L (compared to AWQS of 4 mg/L). In addition, total dissolved solids (TDS) concentrations are still high.

The following sections describe the post-leach mineralogy, the physical characteristics of the fractured rock (porosity, fracture surface, water:rock ratio), and the principal geochemical mechanisms that control the chemical composition of the rinsate over the resting period.

### **4.2.1 Post-leach Mineral Assemblage**

The minerals anticipated to be contacted by leach solution and rinsate are those minerals that occur as fracture linings. These mineral assemblages have been compiled through an intensive

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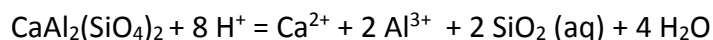
mineralogical characterization undertaken by Excelsior using a variety of analytical techniques including: QEMSCAN (Quantitative Evaluation of Minerals by Scanning Electron Microscope), XRD (X-Ray Diffraction), optical petrography, and whole rock analysis using XRF (X-Ray Fluorescence) and acid digestion with ICP-MS (Inductively Coupled Plasma-Mass Spectroscopy). Ore minerals are not included in the post-leach assemblage as it is assumed that they were leached quantitatively during ISR. In addition, carbonate minerals (primarily calcite and dolomite) are removed from the post-leach mineral assemblage as it is assumed that during active in situ recovery all secondary (fracture-lining) carbonates are dissolved or passivated by overgrowth of secondary gypsum. Passivation of calcite is a well-recognized phenomenon that occurs when secondary gypsum nucleates on, and eventually covers, the exposed calcite surfaces during leaching under acidic conditions (Booth et al., 1997; Huminicki and Rimstidt, 2008). Similar behavior leading to passivation of dolomite has also been observed (Offeddu et al., 2014).

The post-leach mineral assemblage is composed of the silicate and iron oxy-hydroxide phases not dissolved during active leaching as well as secondary gypsum. The relative areal amounts of post-leaching minerals differ by geologic unit (**Figure 2**); however, the principal minerals are consistent across the geologic units and include the following:

- Biotite
- Chlorite/Talc
- Feldspar
- Fe-oxyhydroxides
- Garnet
- Gypsum
- Hornblende
- Muscovite/Kaolinite
- Olivine
- Pyroxene
- Quartz

#### 4.2.2 Silicate Dissolution

The principal elements of silicate/aluminosilicate dissolution are illustrated by the following reaction for the calcium feldspar anorthite ( $\text{CaAl}_2(\text{SiO}_4)_2$ ):



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As the mineral dissolves, it consumes protons ( $H^+$ ) which decreases the acidity (increases pH) of the solution. In addition, metal ions and aqueous silica are released into solution which changes the bulk chemistry of the solution. In the case of anorthite, the metal ions are calcium (Ca) and aluminum (Al); however, depending on the composition of the silicate mineral the major metal cations released may also include (but not be limited to): iron (Fe), magnesium (Mg), sodium (Na), and potassium (K). Neutralization of acidity by silicate minerals is slower than neutralization by carbonate minerals; nevertheless, dissolution of silicate minerals has been shown to contribute substantial neutralization potential during copper leaching and in inactive tailings impoundments (e.g., Blowes and Ptacek, 1994; Jansen and Taylor, 2003). The assumption that all carbonate minerals along the fracture linings are dissolved or passivated prior to the resting period means that modeled neutralization times do not account for any fast-reacting carbonate neutralization potential, only the slower silicate neutralization reactions. However, it is likely that some residual carbonate minerals will remain at the active leach front in the more limestone-dominated host rocks. The model therefore provides conservative estimates of the length of time required for resident solutions to become circumneutral.

The rate at which silicate minerals dissolve is dependent on the pH of the solution. Under lower pH (acidic) conditions, dissolution rates are faster and the rates become slower as pH increases (Brantley et al., 2008). As a result, at the beginning of the resting period when the pH of the solution is approximately 3, silicate dissolution reactions will initially proceed relatively quickly, then, as the pH rises, dissolution rates will decrease. In order to account for this range of dissolution rates, the rates used in the resting models have been chosen from experiments conducted at or near pH 5 (approximately half way between the initial pH of approximately 3 and the final pH of approximately 7). This is a simplification and the degree of uncertainty involved is illustrated by running a single resting model using kinetic rate laws derived at a range of pH values. **Figure 3** shows the time required to reach circumneutral conditions in the Lower Abrigo unit using three separate sets of kinetic rate laws derived at pH approximately 2, 5, and 7. Whenever possible the rate laws for a given mineral at each pH level were taken from the same study in order to minimize variability due to experimental methods and conditions other than changing pH. Inspection of **Figure 3** shows that application of slower dissolution rate laws derived at pH 7 increase the time required to achieve circumneutral conditions from approximately 100 days to approximately 200 days; a factor of two. This uncertainty is taken into account in the recommendation that the ore block be rested for a period of one year between initial and post-rest rinsing.

#### 4.2.3 Water:Rock Ratio

An important factor in determining the rate at which mineral alteration reactions change the bulk chemistry of the fluid is the volume of mineral that interacts with a given volume of fluid,

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or the water:rock ratio (W:R). Water:rock ratio in a fractured system is a function of the secondary (or fracture) porosity of the bulk rock (which provides the volume of fluid available for reaction) together with the surface area of mineral exposed on the fracture surface and the depth of the reaction zone (which together give the volume of mineral available for reaction). Geochemical modeling of the evolution of rinsate in contact with the post-leach mineral assemblage is conducted using a water:rock ratio of 2:1. A brief explanation of the data and methods used in determining this value is provided below.

- Based on geophysical logging of boreholes completed in the Gunnison Project ore deposit, it is estimated that the average secondary porosity (i.e. fracture porosity) in the ore body is approximately 3 percent (see Attachment N of this UIC application). The volume of fluid present in fractures in one cubic foot (ft<sup>3</sup>) of rock with a secondary porosity of 3 percent is 0.03 ft<sup>3</sup>.
- With an understanding of fracture distribution and regional structure, it is possible to determine the area of fracture surface per unit volume of bulk fractured material using statistical methods (Wang, 2005). Based on fracture logging of approximately 10,000 feet (ft) of core drilled at the Gunnison site, Excelsior calculates an average of 9.1 square feet (ft<sup>2</sup>) of fracture surface per ft<sup>3</sup> of ore for the Gunnison Project deposit.
- Gangue acid consumption calculated from metallurgical testing (M3, 2014) suggests that silicate gangue minerals would be leached to an average depth of approximately 0.5 mm (1.64 x 10<sup>-3</sup> ft) over a period of approximately 200 days.

Using the observed and calculated characteristics of the Gunnison Project ore deposit, an average water:rock ratio was calculated as follows:

Water:Rock = Volume of Fluid / Volume of Mineral

$$\begin{aligned} \Rightarrow W:R &= V_f \div V_m \\ &= V_f \div (SA_f \times D_r) \\ &= 0.03 \text{ ft}^3 \div (9.1 \text{ ft}^2 \times 1.64 \times 10^{-3} \text{ ft}) \\ &= 2:1 \end{aligned}$$

Where:

W:R = water:rock ratio

SA<sub>f</sub> = surface area of fracture

V<sub>f</sub> = volume of fluid

D<sub>r</sub> = depth of reaction zone

V<sub>m</sub> = volume of mineral

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#### 4.2.4 Secondary Mineral Precipitation

As the composition of the rinse solution evolves through interaction with the post-leach minerals secondary minerals become stable due to changes in pH, oxidation-reduction potential (ORP), and relative concentrations of major and trace ions. In the current model of the resting period the rinse solution is maintained in place within the ore body and there is little or no exchange of either solutes (through fluid mixing) or gases such as oxygen and carbon dioxide (through gas-phase exchange with the atmosphere or vadose-zone gases). Acidity is neutralized (pH increases) and the environment in the resting portion of the ore body becomes more reducing (ORP decreases). As a result of these changes in the chemical environment, new minerals become stable and precipitate. Following is a summary of the secondary minerals shown to control the chemical composition of the rinse solution at the end of the resting period in the geochemical model. The secondary mineral assemblage is consistent across the four principal geologic units though the relative masses of secondary mineral precipitated varies.

- |                 |   |
|-----------------|---|
| • Barite        | $\text{BaSO}_4$   |
| • Bromellite    | $\text{BeO}$  |
| • Dolomite      | $\text{CaMg}(\text{CO}_3)_2$  |
| • Gibbsite      | $\text{Al}(\text{OH})_3$  |
| • Gypsum        | $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$   |
| • Nontronite-Mg | $\text{Mg}_{.165}\text{Fe}_2\text{Al}_{.33}\text{Si}_{3.67}\text{H}_2\text{O}_{12}$ |
| • Sellaite      | $\text{MgF}_2$  |

**Figure 4** shows the relative masses (in grams mineral per kilogram solution) of the final secondary minerals over the resting period in each of the principal geologic units. For clarity, the primary minerals (those present as part of the post-leach mineral assemblage) and intermediate secondary phases are not included on the figure.

#### 4.2.5 Surface Complexation (Sorption) on Hydrrous Ferric Oxides

An important mechanism in limiting mobility of metal ions is sorption to the surface of hydrrous ferric oxides (HFO) such as goethite, ferrihydrite, and hematite. Surface complexation is modeled in this study using the double-layer model (Dzombak and Morel; 1990). The double-layer model posits the existence of weak and strong bonding sites on the surface of the HFO that react with ions from the solution to form surface complexes. Metal adsorption is highly pH-dependent because at low pH, when proton concentrations are high, many of the bonding sites are protonated (taken up by a proton). This results in the surface having a net positive charge and thus not being available to form complexes with metal cations (Bethke, 2008). However, during ore block closure when protons are consumed by silicate alteration reactions

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and the pH rises, the sorption sites deprotonate and adsorption of metal cations increases. Surface complexation is included in the resting models using the database “FeOH+.dat” which includes data for three HFO species: goethite, ferrihydrite, and hematite based on the extended dataset of Dzombak and Morel (1990) amended to include thallium complexation (Lin and Nriagu, 1998). Binding sites in the resting models are provided by goethite which is a primary gangue mineral in the Gunnison Project ore deposit (and is included in the post-ISR mineral assemblage; **Figure 2**) and by any secondary goethite that is precipitated during the resting period though this mass is relatively minor compared with the mass of primary goethite (< 5 percent). Goethite is modeled with a surface area of 600 m<sup>2</sup>/g and site densities of 0.005 mol sites/mol mineral and 0.2 mol sites/mol mineral for strong and weak sites, respectively (Dzombak and Morel, 1990). It should be noted that there are several adsorption mechanisms that are not accounted for in this approach including co-precipitation with iron oxides and adsorption to clay minerals and aluminum hydroxide phases such as gibbsite. Thus it is anticipated that more adsorption/surface complexation/co-precipitation reactions will likely occur in the field than are included in the model and the simulated aqueous metals concentrations in the rinsate are conservative.

### 4.3 Post-Rest Rinsing and Closure Fluid Compositions

In order to further reduce regulated constituents and TDS the resting solution will be rinsed from the ore block by injecting clean site groundwater (makeup water) via injection wells and extracting the mixture via recovery wells. Geochemical modeling was used to predict the pore volumes of rinsate required and the composition of the fluid in the rinsed portion of the ore block after the final rinse. The model, implemented in the REACT module of GWB, is based on the following assumptions:

- Initial conditions for the post-rest rinsing models include the equilibrium fluid and mineral assemblage simulated at the end of one year of resting (see **Section 4.2** for details regarding modeling of rest period) for each of the principal geologic units (Upper Abrigo, Middle Abrigo, Lower Abrigo and Martin)
- Secondary minerals present at the end of the resting period include:
  - Barite  $\text{BaSO}_4$
  - Bromellite  $\text{BeO}$
  - Dolomite  $\text{CaMg}(\text{CO}_3)_2$
  - Gibbsite  $\text{Al}(\text{OH})_3$
  - Gypsum  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
  - Nontronite-Mg  $\text{Mg}_{.165}\text{Fe}_2\text{Al}_{.33}\text{Si}_{3.67}\text{H}_2\text{O}_{12}$
  - Sellaite  $\text{MgF}_2$
- The post-rest fluid is mixed with makeup water to provide a mixture that is approximately 10 percent post-rest solution and 90 percent groundwater

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- The secondary mineral assemblage after mixing with makeup water is the same as at the end of the resting period except that fluorite ( $\text{CaF}_2$ ) replaces sellaite ( $\text{MgF}_2$ ) as the stable fluoride mineral.
  - Rinsing of each of the principal geologic units is simulated separately and then a weighted average of the four post-rinse solutions is calculated based on the relative volumes of each unit in the Excelsior geologic block model (M3, 2014).

Model results indicate that a mixture of 10 percent post-rest fluid and 90 percent makeup water (site groundwater) would meet all Arizona AWQs and the sulfate concentration would be controlled by equilibrium with gypsum. Rinsing of test columns indicates that approximately two pore volumes of rinsing will be necessary to achieve a mixture of 90 percent groundwater and 10 percent post-rest solution (see Attachment H-3 of this UIC application).

The forecast chemical composition of the fluid resident in the ore block at closure is provided in **Table 1**. This reported composition is achieved using the following approach:

- At the end of ISR, PLS remaining in the ore block is rinsed using makeup water. This initial rinse results in a mixture of approximately 5 percent PLS and 95 percent makeup water and is anticipated to require three pore volumes.
- After the initial rinse, the PLS/groundwater mixture is maintained in contact with the post-leach mineral assemblage for one year; during this time pH becomes circumneutral and metal concentrations are reduced by precipitation of secondary minerals and surface complexation (sorption) on hydrous ferric oxides.
- After the resting period, the ore block is rinsed with two pore volumes of makeup water which results in a mixture of approximately 10 percent post-rest fluid and 90 percent groundwater

Concentrations in the modeled final fluid composition (and in all forecast solutions) are provided to one significant figure in order to represent a reasonable level of precision in the modeling results. When modeled concentrations fall below the method detection limit (MDL) as provided by SVL (**Exhibit 1A**) they are reported as < MDL.

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## 5.0 Upset Conditions

Should hydraulic control be lost (i.e., pumping ceases for long enough for any local, mining-induced changes in hydraulic gradient to reverse and return to the regional gradient) there would be potential for PLS to leave the wellfield and migrate down-gradient to the east. Should this occur, it is anticipated that PLS would leave the mineralized rocks of the ore body and enter the Escabrosa and Horquilla Limestone units (see Figures F-6 and F-8 of this UIC application). These formations are both predominantly composed of calcite with some minor subordinate clastic and dolomitic beds in the Horquilla and a dolomitic layer at the base of the Escabrosa (Cooper and Silver, 1964).

### 5.1 Geochemical Modeling Approach

Interaction of PLS with the Escabrosa and Horquilla limestones is simulated by equilibrating the PLS solution composition provided in **Table 1** with calcite ( $\text{CaCO}_3$ ). The initial PLS acid content was set at 15 mg/L; it is understood that the bulk PLS composition in the ore block is likely to be lower than this but the highest anticipated operational value was used as a conservative assumption. It should be noted that there is some potential for injection of solutions containing up to 50 g/L free acid; however, as these high acid concentrations would only be used if acid consumption was very high, acidity would be quickly neutralized. It is not anticipated that free acid concentrations above 15 g/L would generally persist in the ore block.

#### 5.1.1 Kinetic Calcite Dissolution

Calcite was modeled as a kinetic phase using the kinetic rate law of Plummer et al. (1979) derived at pH 7 in order to estimate the maximum time required to neutralize the PLS. During the initial interaction of PLS with calcite the rates would be expected to be up to three orders of magnitude faster. This assumption also allows for the presence of some dolomite in the limestone units that would react more slowly with reaction rates on the order of one to two orders of magnitude slower than calcite reaction rates at a given pH (Busenberg and Plummer, 1982). Interaction with dolomite is not explicitly included in the model simulation as both the Horquilla and the Escabrosa Limestones are predominately composed of calcite (Cooper and Silver, 1964).

#### 5.1.2 Porosity and Water:Rock Ratio

Porosity was modeled at 3 percent as described in **Section 4.2.3** above. Therefore, model results represent reaction of PLS that initially occupied a given volume in the ore body with the same volume of unaltered limestone. The water:rock ratio used to represent upset conditions



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in the model is an order of magnitude larger than that used for the resting period (20:1 compared with 2:1) to account for the much smaller leaching depth anticipated due to shorter leaching times in the upset model (i.e. days vs. months).

### 5.1.3 Oxygen and Carbon Dioxide Fugacity

Oxygen fugacity ( $fO_2$ ) is fixed at half of atmospheric ( $\log fO_2 = -1.0$ ) to represent the somewhat reduced composition of the PLS (initial redox conditions depend on whether the fugitive PLS is recently injected (closer to equilibrium with atmosphere) or has been in the ore block for longer (and is more reduced)). Carbon dioxide fugacity ( $fCO_2$ ) is fixed at ten times nominal atmospheric ( $\log fCO_2 = -2.5$ ). Not all the  $CO_2$  evolved during the reaction between sulfuric acid in the PLS and solid-phase calcite will remain in solution. Instead it is anticipated that there will be loss to the vadose zone (and eventually to the surface) through fractures. However, gas exchange will not occur quickly enough for the fluid  $CO_2$  to be in equilibrium with atmospheric  $CO_2$ ; fixing the  $fCO_2$  at ten times atmospheric recognizes that  $CO_2$  concentration in the fluid will likely be substantially elevated.

## 5.2 Geochemical Modeling Results

**Figure 5** shows the evolution of PLS pH due to interaction with calcite. The neutralization reaction occurs very quickly with modeled pH of the solution reaching circumneutral within approximately one day. As the pH approaches circumneutral, metal concentrations are controlled by precipitation of secondary mineral phases and through sorption on the surface of secondary hydrous ferric oxide (HFO) precipitates. **Figure 6** shows the secondary minerals that precipitate as pH increases. The final secondary mineral assemblage consists of the following minerals:

- |                       |                      |
|-----------------------|----------------------|
| • Brochantite         | $Cu_4(SO_4)(OH)_6$   |
| • Bromellite          | $BeO$                |
| • Chlorargyrite       | $AgCl$               |
| • Dolomite            | $CaMg(CO_3)_2$       |
| • Ferrihydrite        | $Fe(OH)_3$           |
| • Fluorite            | $CaF_2$              |
| • Gibbsite            | $Al(OH)_3$           |
| • Gypsum              | $CaSO_4 \cdot 2H_2O$ |
| • Hydrozincite        | $Zn_5(OH)_6(CO_3)_2$ |
| • $SiO_2$ (amorphous) | $Si(O_2)_{am}$       |
| • Otavite             | $CdCO_3$             |
| • Rhodochrosite       | $MnCO_3$             |
| • Sphaerocobaltite    | $CoCO_3$             |

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Once the fugitive PLS reaches circumneutral pH the majority of regulated constituents fall below Arizona AWQS. The exceptions are: 1) cadmium with a modeled concentration of 0.4 mg/L (compared with AWQS of 0.005 mg/L); and, 2) selenium with a modeled concentration of 0.05 mg/L which is equal to the AWQS. In addition, uranium concentrations remain somewhat elevated at 0.4 mg/L which is above the U.S. EPA maximum contaminant level (MCL) of 0.03 mg/L. Sulfate concentration is controlled by precipitation of gypsum and is computed to be approximately 2,000 mg/L.

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## 6.0 References Cited

- Alpers, C.N., Blowes, D.W., Nordstrom, D.K., and Jambor J.L. 1994. Secondary Minerals and Acid Mine-water Chemistry. In Jambor, J.L. and Blowes, D.W., eds. Short Course Handbook on Environmental Geochemistry of Sulfide Mine-wastes. Mineralogical Association of Canada, Waterloo, Ontario. May 1994. pp. 247-270.
- Arizona Department of Environmental Quality (ADEQ). 2004. *Arizona Mining Guidance Manual BADCT*, Aquifer Protection Program, Publication # TB 04-01, Phoenix, Arizona.
- Bartlett, R.W. 1992. Solution Mining: Leaching and Fluid Recovery of Materials, Gordon and Breach Publishers, Luxembourg.
- Bethke, C.M. 2008. Geochemical and Biogeochemical Reaction Modeling, 2<sup>nd</sup> edition, Cambridge University Press, New York.
- Bethke, C.M., and Yeakel, S. 2014. The Geochemist's Workbench Release 10.0, Reaction Modeling Guide, Aqueous Solutions, LLC. Champaign, Illinois.
- Bikerman Engineering and Technology Associates. 2007. Johnson Camp Mine Project, Feasibility Study, Cochise County, Arizona. Report submitted to Nord Resources Corp, September 28, 2007.
- Blowes, D.W., and Ptacek, C.J. 1994. Acid Neutralization Mechanisms in Inactive Mine Tailings. In Jambor, J.L. and Blowes, D.W. (Eds.), Short Course Handbook on Environmental Geochemistry of Sulfide Mine-wastes. Mineralogical Association of Canada, Waterloo, Ontario. May 1994. pp. 271-292.
- Booth, J., Hong, Q., Compton, R.G., Prout, K., and Payne, R.M. 1997. Gypsum Overgrowths Passivate Calcite to Acid Attack. J. Colloid Interface Sci., 192(1):207-214.
- Brandt, F., Bosbach, D., Krawczyk-Barsch, E., Arnold, T., and Bernhard, G. 2003. Chlorite dissolution in the acid pH-range: A combined microscopic and macroscopic approach. Geochimica et Cosmochimica Acta, 67(8):1451-1461.
- Brantley, S.L., Kubicki, J.D., and White, A.F. (Eds). 2008. Kinetics of Water-Rock Interaction. Springer, New York.

- 
- Busenberg, E. and Plummer, L.N. 1982. The Kinetics of Dissolution of Dolomite in CO<sub>2</sub>-H<sub>2</sub>O Systems at 1.5 to 65°C and 0 to 1 atm P<sub>CO2</sub>. *American Journal of Science*, 282: 45-78.
- Cooper and Silver. 1964. *Geology and Ore Deposits of the Dragoon Quadrangle, Cochise County, Arizona*. USGS Professional Paper 416. United States Government Printing Office, Washington, DC.
- Dickens, C.M. 2003. Characterization of Hydrogeologic Conditions, Johnson Camp Mine, Cochise County, Arizona. Report submitted to Nord Resources Corporation, July 21, 2003.
- Dzombak, D.A. and Morel, F.M.M. 1990. *Surface Complexation Modeling*. Wiley, New York.
- Huminicki, D.M.C., and Rimstidt, J.D. 2008. Neutralization of Sulfuric Acid Solutions by Calcite Dissolution and the Application to Anoxic Limestone Drain Design. *Applied Geochemistry*, 23: 143-165.
- International Network for Acid Prevention (INAP). 2009. *Global Acid Rock Drainage Guide (GARD Guide)*; <http://www.gardguide.com/>
- Jambor, J.L. 2003. Mine-Waste Mineralogy and Mineralogical Perspectives of Acid-Base Accounting. In: J.L. Jambor, D.W. Blowes and A.I.M. Ritchie (Eds.), *Environmental Aspects of Mine Wastes, Short Course Series Vol. 31*, Mineralogical Association of Canada, 117-146.
- Jansen M. and Taylor, A. 2003. Overview of Gangue Mineralogy Issues in Oxide Copper Heap Leaching. ALTA 2003 Copper-8, Technical Proceedings – Global technical interchange, 22-23 May 2003. Rendezvous Observation City, Hotel Perth, Western Australia.
- Jeschke, A.A., Vosbeck, K., and Dreybrodt, W. 2001. Surface controlled dissolution rates of gypsum in aqueous solutions exhibit non-linear dissolution kinetics. *Geochimica et Cosmochimica Acta*, 65(1):27-34.
- Lin, T.S. and Nriagu, J.O. 1998. Speciation of Thallium in Natural Waters. In: *Thallium in the Environment*, Vol. 29, *Advances in Environmental Sci. and Tech.*, Ed., J.O. Nriagu, Wiley and Sons, NY, pp.31-44.
- M3. 2014. Gunnison Copper Project NI 43-101 Technical Report, Prefeasibility Study. Report submitted to Excelsior Mining Corp, February 14, 2014.

- 
- Nordstrom, D.K. and Alpers, C.N. 1999. Geochemistry of Acid Mine Waters. In G.S. Plumlee, and M.J. Logsdon, (Eds.), The Environmental Geochemistry of Mineral Deposits, Reviews in Economic Geology Vol. 6A, Soc. Econ. Geol., Littleton, Colorado, pp. 133-160.
- Offeddu, F.G., Cama, J., Soler, J.M., and Putnis, C.V. 2014. Direct nanoscale observations of the coupled dissolution of calcite and dolomite and the precipitation of gypsum. *Beilstein Journal of Nanotechnology*, 5:1245-1253
- Plummer, L.N., Parkhurst, D.L., and Wigley, T.M.L. 1979. Critical Review of the Kinetics of Calcite Dissolution and Precipitation. In: *Chemical Modeling in Aqueous Systems*, Ed. E. Jenne, ACS Symposium Series, American Chemical Society, Washington, DC., 1979. pp. 537-573.
- Wang, X. 2005. Stereological Interpretation of Rock Fracture Traces on Borehole Walls and Other Cylindrical Surfaces. Dissertation submitted to Virginia Polytechnic Institute and State University, Department of Civil Engineering. September 16, 2005

**TABLE 1. ESTIMATED COMPOSITIONS OF IN SITU RECOVERY PROCESS SOLUTIONS  
GUNNISON PROJECT, COCHISE COUNTY, ARIZONA**

Analyte	Estimated Composition of Make-up Water <sup>a</sup>	Sulfuric Acid (93.0 - 98.5 %)	Forecast Composition of Barren Leach Solution	Forecast Composition of Pregnant Leach Solution	Forecast Composition of Groundwater After Block Rinsing	Arizona AWQS <sup>b</sup>
	mg/L <sup>c</sup>	mg/kg <sup>d</sup>	mg/L	mg/L	mg/L	mg/L
<b>METALS</b>						
Aluminum	<0.04	NR <sup>e</sup>	8000	8000	<0.04	none
Antimony	<0.00019	0.05 - 0.5	<0.005	<0.005	<0.00019	0.006
Arsenic	0.002	0.1 - 4	<0.005	<0.005	0.002	0.05
Barium	0.1	NR	0.05	0.05	0.1	2
Beryllium	0.0003	NR	4	4	<0.000048	0.004
Cadmium	<0.000072	0.1 - 10	4	4	<0.000072	0.005
Calcium	50	NR	500	400	600	none
Chromium	0.006	1	1	1	0.005	0.1
Cobalt	0.00008	NR	20	20	0.003	none
Copper	0.01	0.2 - 0.5	150	1500	0.01	none
Iron	0.05	7 - 50	1000	1000	<0.026	none
Lead	0.00009	0.1 - 10	0.005	0.005	<0.000031	0.05
Magnesium	10	NR	6000	6000	100	none
Manganese	0.007	0.05 - 1	1000	1000	0.04	none
Mercury	<0.0002	1	<0.001	<0.001	<0.0002	0.002
Nickel	0.001	2	20	20	0.001	0.1
Potassium	1	NR	100	100	2	none
Selenium	0.003	0.1	0.05	0.05	0.002	0.05
Silver	<0.000021	NR	0.2	0.2	<0.000021	none
Sodium	30	NR	100	100	30	none
Thallium	<0.000026	NR	4	4	<0.000026	0.002
Zinc	0.9	1 - 2	800	800	0.8	none

**TABLE 1 (CONT). ESTIMATED COMPOSITIONS OF IN SITU RECOVERY PROCESS SOLUTIONS  
GUNNISON PROJECT, COCHISE COUNTY, ARIZONA**

Analyte	Estimated Composition of Make-up Water <sup>a</sup>	Sulfuric Acid (93.0 - 98.5 %)	Forecast Composition of Barren Leach Solution	Forecast Composition of Pregnant Leach Solution	Forecast Composition of Groundwater After Block Rinsing	Arizona AWQS <sup>b</sup>
	mg/L <sup>c</sup>	mg/kg <sup>d</sup>	mg/L	mg/L	mg/L	mg/L
<b>ANIONS</b>						
Alkalinity (mg/kg as CaCO <sub>3</sub> ) <sup>f</sup>	200	NR	<1.0	<1.0	6	none
Chloride	30	5 - 16	30	30	30	none
Fluoride	3	NR	900 - 1200	900 - 1200	3	4
Nitrate (as N) <sup>g</sup>	2	5	5	5	2	10
Sulfate	20	965000	90000	90000	2000	none
<b>WATER QUALITY PARAMETERS</b>						
pH (s.u.) <sup>h</sup>	7.5	-1.3	0.6 - 1.8	1.6 - 2.1	8.0	none
TDS <sup>i</sup>	300	965000	100000	100000	3000	none
<b>RADIOLOGICALS</b>						
Ra-226 + Ra-228 (pCi/L) <sup>j</sup>	0.4	NR	<1.3	<1.3	<1.3	5
Uranium	0.004	NR	1	1	0.003	none

<sup>a</sup> Estimated make-up water composition based on analysis of Gunnison site groundwater (Well NSH-006, sampled 13 May 2015).

See Exhibit 1 for laboratory reports and field parameters

<sup>b</sup> AWQS = Aquifer Water Quality Standards (Arizona Administrative Code R18-11-406)

<sup>c</sup> mg/L = milligrams per liter

<sup>d</sup> mg/kg = milligrams per kilogram (units consistent with data provided by suppliers; see Exhibit 3)

<sup>e</sup> NR = not reported

<sup>f</sup> Carbonate alkalinity as equivalent calcium carbonate

<sup>g</sup> Nitrate as nitrogen

<sup>h</sup> pH in standard units

<sup>i</sup> TDS = total dissolved solids

<sup>j</sup> Radium-226 plus radium-228 in picocuries per liter

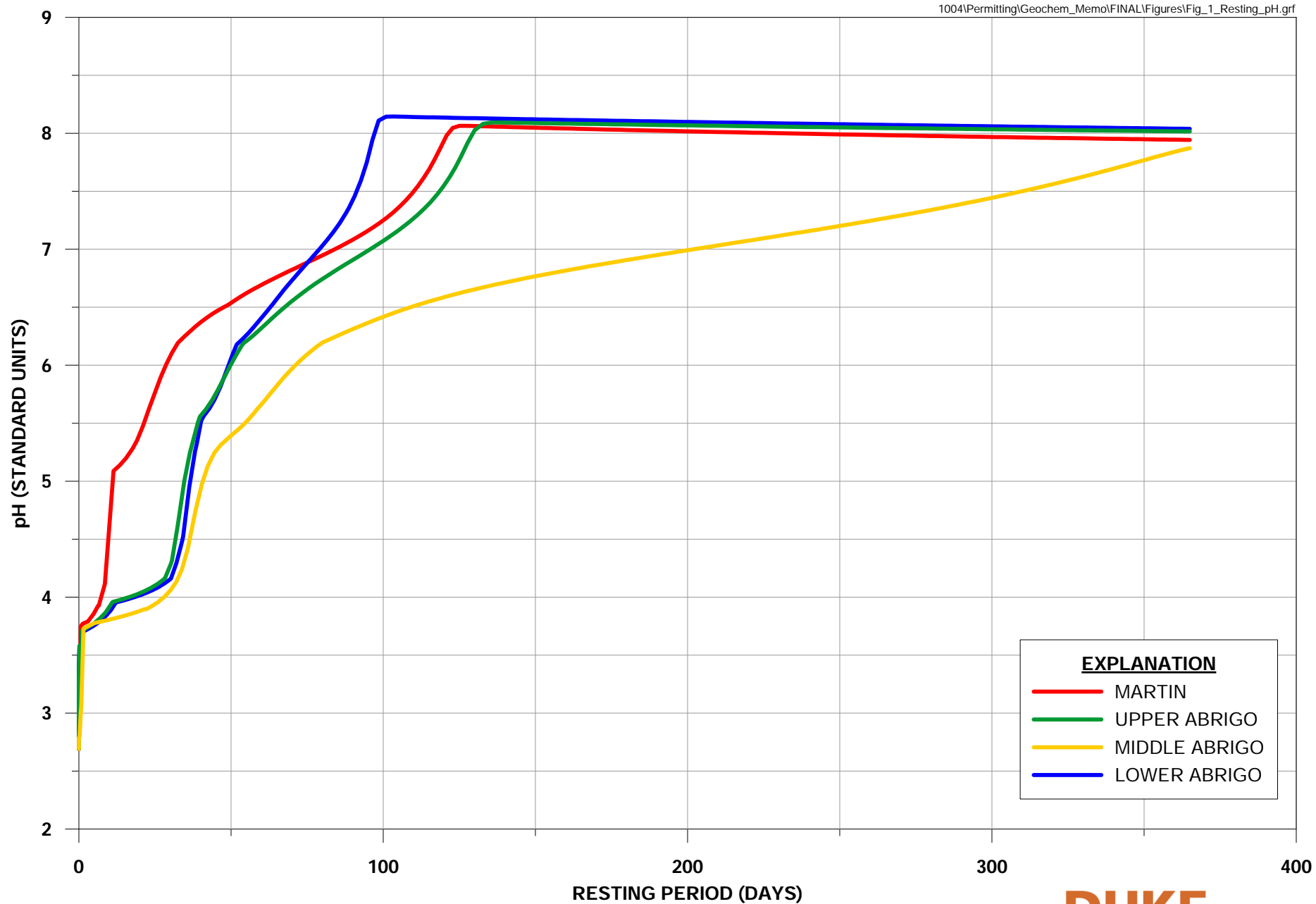
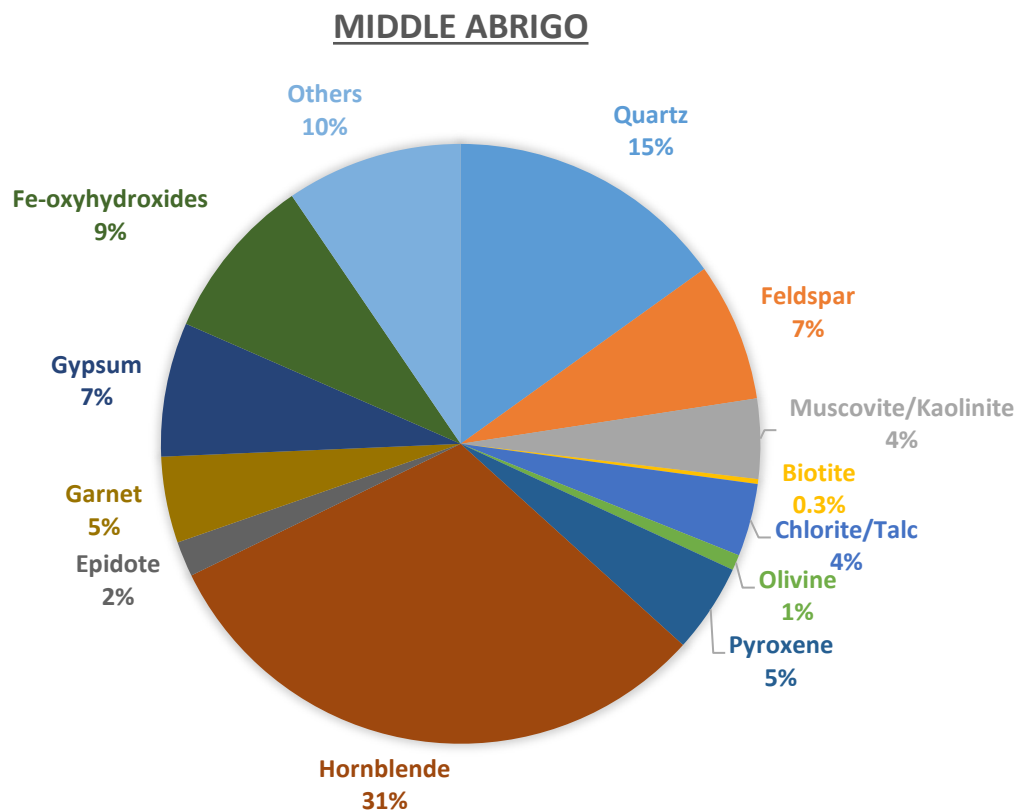
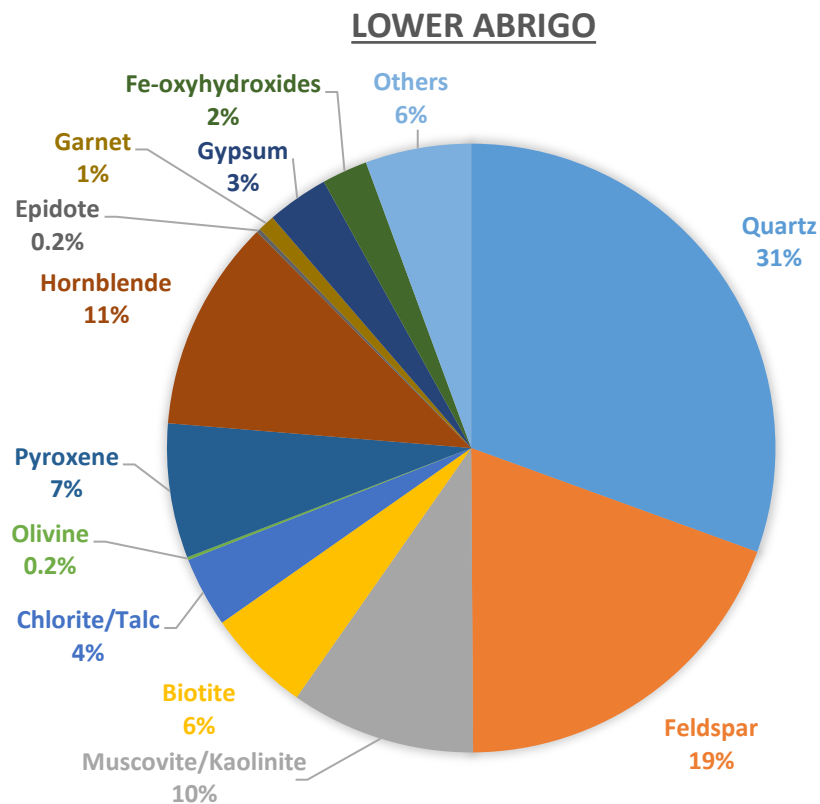


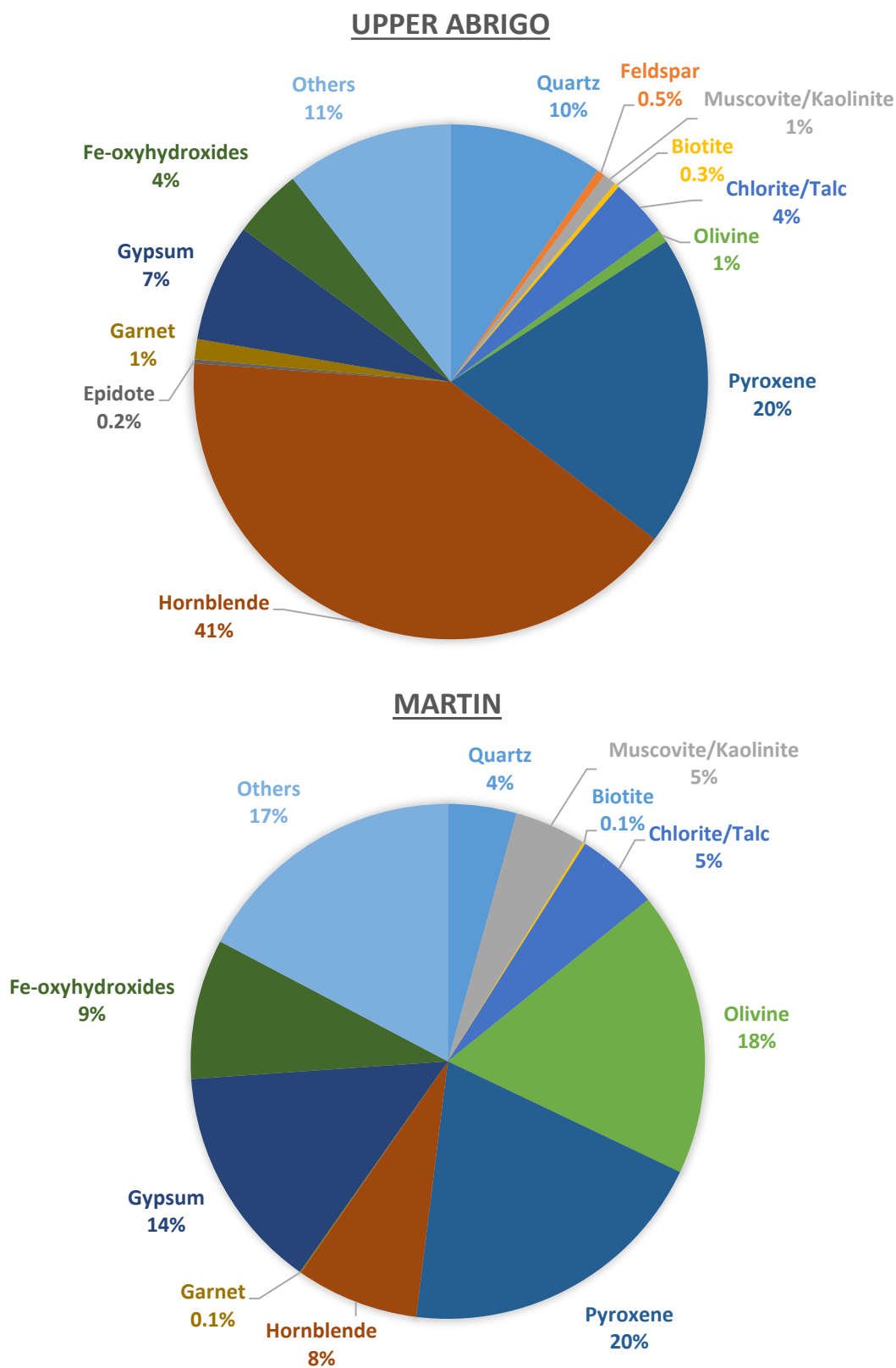
FIGURE 1: MODELED EVOLUTION OF pH IN PRINCIPAL GEOLOGIC UNITS DURING RESTING PERIOD





**FIGURE 2: SUMMARY OF POST-LEACH MINERAL ASSEMBLAGES IN PRINCIPAL GEOLOGIC UNITS**

Relative area percent of mineral phases in fracture linings in the Gunnison Project ore body after completion of in situ recovery. Note: "Others" category includes leached copper minerals and phases present at <0.1 area percent.



**FIGURE 2 (CONT.): SUMMARY OF POST-LEACH MINERAL ASSEMBLAGES IN PRINCIPAL GEOLOGIC UNITS**

Relative area percent of mineral phases in fracture linings in the Gunnison Project ore body after completion of in situ recovery. Note: "Others" category includes leached copper minerals and phases present at <0.1 area percent.

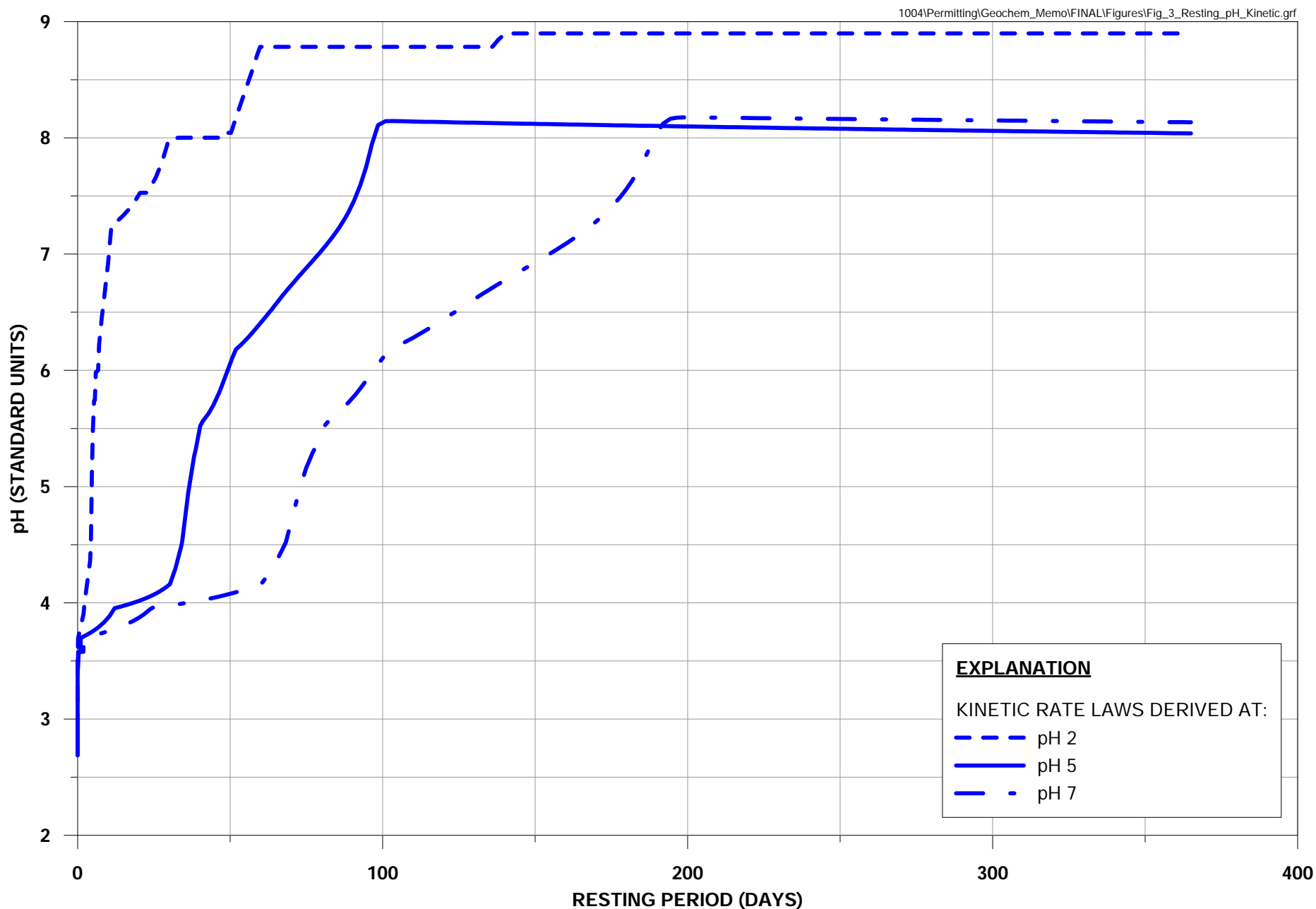
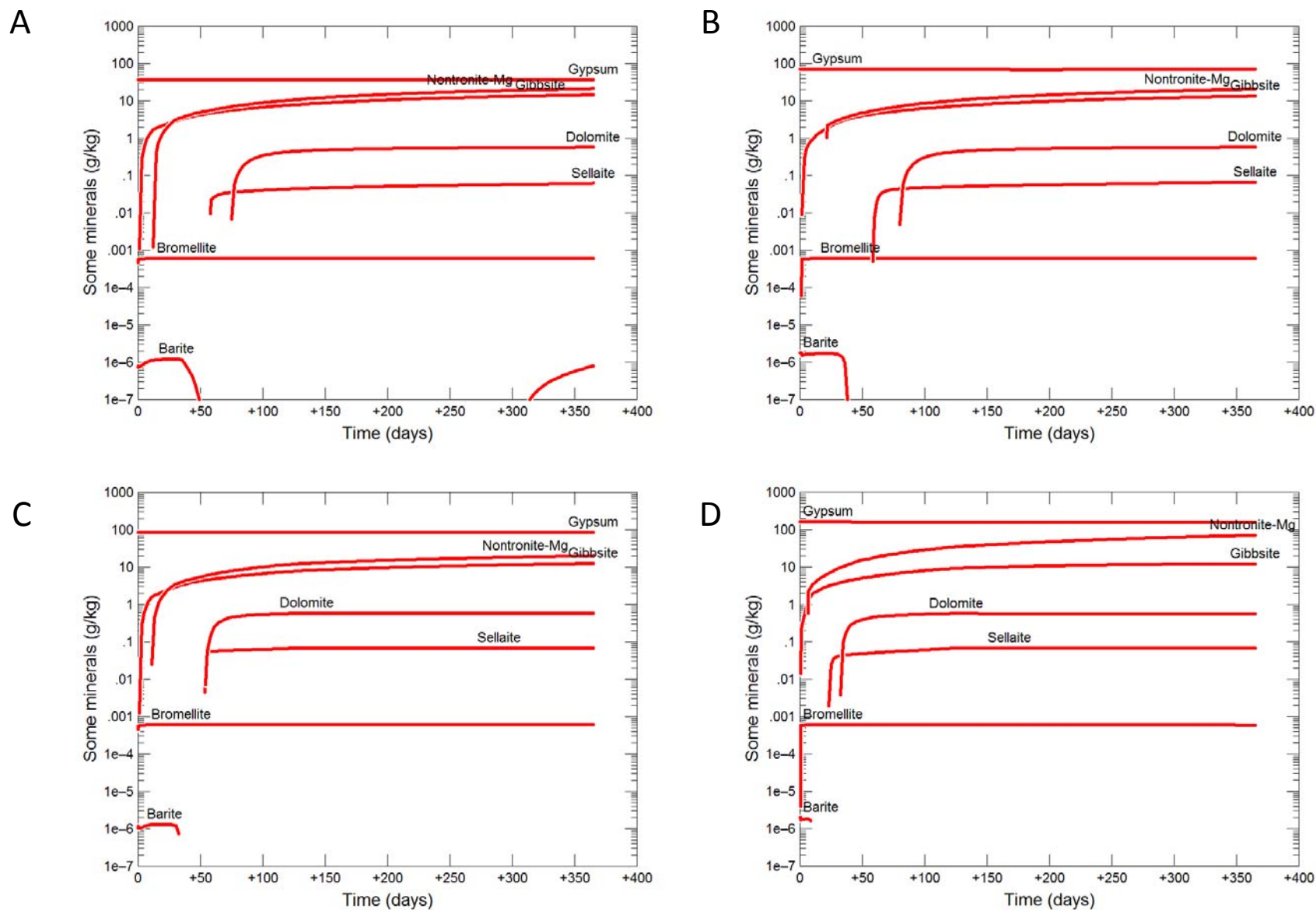
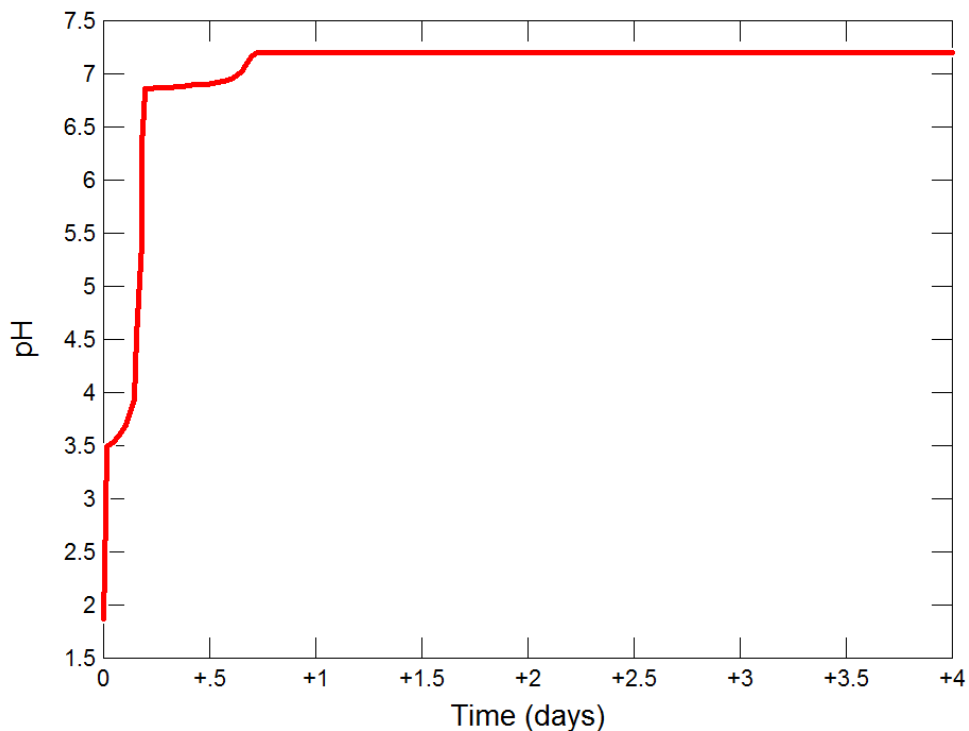


FIGURE 3. MODELED EVOLUTION OF pH IN THE LOWER ABRIGO GEOLOGIC UNIT DURING RESTING PERIOD USING KINETIC RATE LAWS DERIVED AT pH 2, 5, AND 7

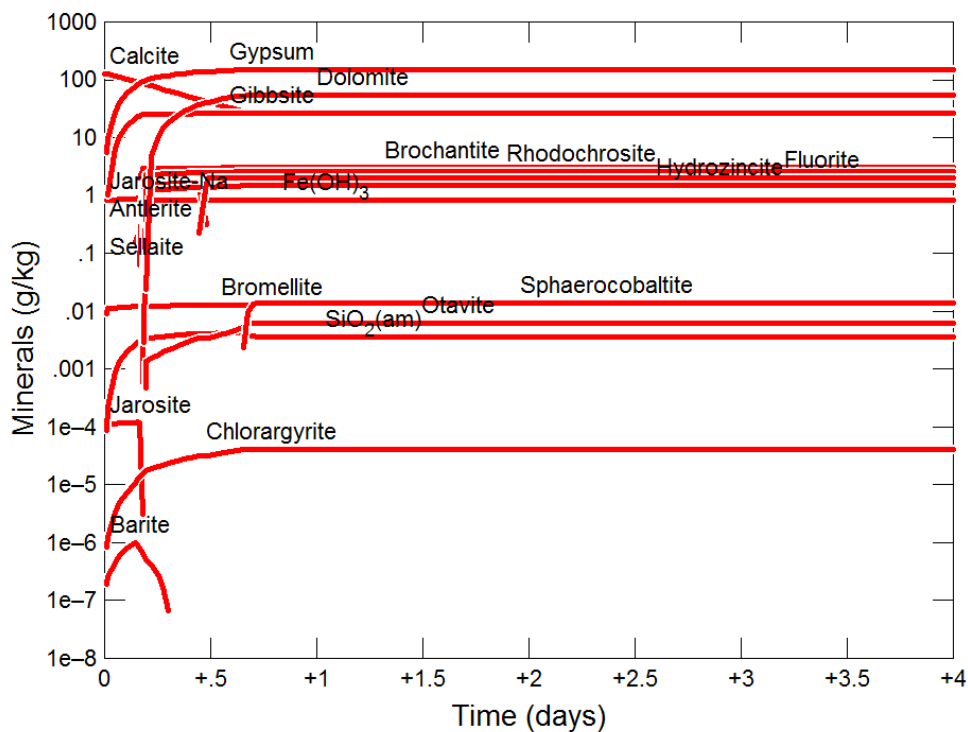


**FIGURE 4. MODELED RELATIVE MASSES (GRAMS MINERAL PER KILOGRAM SOLUTION) OF FINAL SECONDARY MINERALS OVER THE RESTING PERIOD IN EACH OF THE PRINCIPAL GEOLOGIC UNITS**

A = Lower Abrigo, B = Middle Abrigo, C = Upper Abrigo, D = Martin



**FIGURE 5. MODELED EVOLUTION OF pH IN FUGITIVE PREGNANT LEACH SOLUTION REACTING WITH CALCITE**



**FIGURE 6. MODELED FORMATION OF SECONDARY MINERALS IN RESPONSE TO NEUTRALIZATION OF PREGNANT LEACH SOLUTION BY CALCITE**

**EXHIBIT 1**

**GROUNDWATER LABORATORY REPORTS AND FIELD PARAMETERS**

**EXHIBIT 1A**

**GROUNDWATER LABORATORY REPORTS**



[www.svl.net](http://www.svl.net)

One Government Gulch - PO Box 929

Kellogg ID 83837-0929

(208) 784-1258

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Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**

Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

## ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Sampled By	Date Received	Notes
NSH-006-051315	W5E0290-01	Ground Water	13-May-15 14:05	KF	14-May-2015	

Solid samples are analyzed on an as-received, wet-weight basis, unless otherwise requested. Non-Detects are reported at the MDL.

Sample preparation is defined by the client as per their Data Quality Objectives.

This report supercedes any previous reports for this Work Order. The complete report includes pages for each sample, a full QC report, and a notes section.

The results presented in this report relate only to the samples, and meet all requirements of the NELAC Standards unless otherwise noted.





Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

Client Sample ID: **NSH-006-051315**SVL Sample ID: **W5E0290-01 (Ground Water)**

Sample Report Page 1 of 2

Sampled: 13-May-15 14:05

Received: 14-May-15

Sampled By: KF

Method	Analyte	Result	Units	RL	MDL	Dilution	Batch	Analyst	Analyzed	Notes
<b>Metals (Dissolved)</b>										
EPA 200.7	Aluminum	< 0.04	mg/L	0.08	0.04		W520254	DT	05/29/15 12:23	U
EPA 200.7	Calcium	49.5	mg/L	0.100	0.029		W520254	DT	05/29/15 12:23	
EPA 200.7	Iron	0.052	mg/L	0.060	0.026		W520254	DT	05/29/15 14:18	J
EPA 200.7	Magnesium	12.1	mg/L	0.20	0.11		W520254	DT	05/29/15 12:23	
EPA 200.7	Potassium	1.27	mg/L	0.50	0.17		W520254	DT	05/29/15 12:23	
EPA 200.7	Silica (SiO <sub>2</sub> )	36.8	mg/L	0.17	0.12		W520254	DT	05/29/15 12:23	B7
EPA 200.7	Sodium	28.0	mg/L	0.50	0.05		W520254	DT	05/29/15 12:23	
EPA 200.8	Antimony	< 0.00019	mg/L	0.00300	0.00019		W519088	KWH	05/19/15 07:10	U
EPA 200.8	Arsenic	0.00156	mg/L	0.00300	0.00027		W519088	KWH	05/19/15 07:10	J
EPA 200.8	Barium	0.103	mg/L	0.00100	0.000099		W519088	KWH	05/19/15 07:10	
EPA 200.8	Beryllium	0.00034	mg/L	0.00020	0.000048		W519088	KWH	05/19/15 07:10	
EPA 200.8	Boron	0.0358	mg/L	0.0050	0.0012		W519088	KWH	05/19/15 07:10	
EPA 200.8	Cadmium	< 0.000072	mg/L	0.00020	0.000072		W519088	KWH	05/19/15 07:10	U
EPA 200.8	Chromium	0.0060	mg/L	0.0015	0.0004		W519088	KWH	05/19/15 07:10	
EPA 200.8	Cobalt	0.00008	mg/L	0.00100	0.000054		W519088	KWH	05/19/15 07:10	J
EPA 200.8	Copper	0.0115	mg/L	0.00100	0.00015		W519088	KWH	05/19/15 07:10	
EPA 200.8	Lead	0.00009	mg/L	0.00300	0.000031		W519088	KWH	05/19/15 07:10	J
EPA 200.8	Manganese	0.00712	mg/L	0.00100	0.000025		W519088	KWH	05/19/15 07:10	
EPA 200.8	Molybdenum	0.0163	mg/L	0.00100	0.00009		W519088	KWH	05/19/15 07:10	
EPA 200.8	Nickel	0.0014	mg/L	0.0010	0.0004		W519088	KWH	05/19/15 07:10	
EPA 200.8	Selenium	0.0025	mg/L	0.0030	0.0006		W519088	KWH	05/19/15 07:10	J
EPA 200.8	Silver	< 0.000021	mg/L	0.000100	0.000021		W519088	KWH	05/19/15 07:10	U
EPA 200.8	Thallium	< 0.000026	mg/L	0.00100	0.000026		W519088	KWH	05/19/15 07:10	U
EPA 200.8	Uranium	0.00363	mg/L	0.00100	0.000014		W519088	KWH	05/19/15 07:10	
EPA 200.8	Vanadium	0.0040	mg/L	0.0030	0.0009		W519088	KWH	05/19/15 07:10	
EPA 200.8	Zinc	0.900	mg/L	0.0050	0.0010		W519088	KWH	05/19/15 07:10	

**Metals (Filtered)**

EPA 245.1	Mercury	< 0.00004	mg/L	0.00020	0.00004		W520309	STA	05/20/15 13:44	U
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**Classical Chemistry Parameters**

SM 2320B	Total Alkalinity	180	mg/L as CaCO <sub>3</sub>	1.0			W520293	AGF	05/20/15 10:48	
SM 2320B	Bicarbonate	180	mg/L as CaCO <sub>3</sub>	1.0			W520293	AGF	05/20/15 10:48	
SM 2320B	Carbonate	0	mg/L as CaCO <sub>3</sub>	1.0			W520293	AGF	05/20/15 10:48	U
SM 2320B	Hydroxide	0	mg/L as CaCO <sub>3</sub>	1.0			W520293	AGF	05/20/15 10:48	U
SM 2510 B	Specific conductance	436	µmhos/cm	5.00			W520271	JDM	05/15/15 11:40	
SM 2540 C	Total Diss. Solids	284	mg/L	10			W520262	JDM	05/15/15 16:25	
SM 4500 H B	pH @26.0°C	8.02	pH Units				W520293	AGF	05/20/15 10:48	H5
SM 4500-CN-I	Cyanide (WAD)	< 0.0025	mg/L	0.0100	0.0025		W521183	MAD	05/21/15 13:10	U
SM 4500-P-E	Orthophosphate as P	0.016	mg/L	0.010	0.006		W520289	MCB	05/15/15 12:20	
SM 4500-S-F	Sulfide	0.48	mg/L	1.00	0.39		W521066	SM	05/19/15 16:23	J
SM 5310B	Total Organic Carbon	< 0.24	mg/L	1.00	0.24		W521129	SM	05/21/15 19:55	U



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

Client Sample ID: **NSH-006-051315**SVL Sample ID: **W5E0290-01 (Ground Water)****Sample Report Page 2 of 2**

Sampled: 13-May-15 14:05

Received: 14-May-15

Sampled By: KF

Method	Analyte	Result	Units	RL	MDL	Dilution	Batch	Analyst	Analyzed	Notes
<b>Anions by Ion Chromatography</b>										
EPA 300.0	<b>Chloride</b>	26.2	mg/L	2.00	0.56	10	W520249	MCE	05/14/15 12:18	D2
EPA 300.0	<b>Fluoride</b>	2.53	mg/L	0.100	0.022		W520249	MCE	05/14/15 11:59	
EPA 300.0	<b>Nitrate as N</b>	1.84	mg/L	0.050	0.008		W520249	MCE	05/14/15 11:59	
EPA 300.0	<b>Nitrite as N</b>	< 0.014	mg/L	0.050	0.014		W520249	MCE	05/14/15 11:59	U
EPA 300.0	<b>Sulfate as SO4</b>	24.4	mg/L	0.30	0.05		W520249	MCE	05/14/15 11:59	

**Cation/Anion Balance and TDS Ratios**

Cation Sum: 4.75 meq/L      Anion Sum: 5.11 meq/L      C/A Balance: -3.63 %      Calculated TDS: 297      TDS/cTDS: 0.96      TDS/eC: 0.65

This data has been reviewed for accuracy and has been authorized for release by the Laboratory Director or designee.

**John Kern**  
Laboratory Director



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

**Quality Control - BLANK Data**

Method	Analyte	Units	Result	MDL	MRL	Batch ID	Analyzed	Notes
<b>Metals (Dissolved)</b>								
EPA 200.7	Aluminum	mg/L	<0.04	0.04	0.08	W520254	29-May-15	U
EPA 200.7	Calcium	mg/L	<0.029	0.029	0.100	W520254	29-May-15	U
EPA 200.7	Iron	mg/L	<0.026	0.026	0.060	W520254	29-May-15	U
EPA 200.7	Magnesium	mg/L	<0.11	0.11	0.20	W520254	29-May-15	U
EPA 200.7	Potassium	mg/L	<0.17	0.17	0.50	W520254	29-May-15	U
EPA 200.7	Silica (SiO <sub>2</sub> )	mg/L	<0.12	0.12	0.17	W520254	29-May-15	B7,U
EPA 200.7	Sodium	mg/L	<0.05	0.05	0.50	W520254	29-May-15	U
EPA 200.8	Antimony	mg/L	<0.00019	0.00019	0.00300	W519088	19-May-15	U
EPA 200.8	Arsenic	mg/L	<0.00027	0.00027	0.00300	W519088	19-May-15	U
EPA 200.8	Barium	mg/L	<0.000099	0.000099	0.00100	W519088	19-May-15	U
EPA 200.8	Beryllium	mg/L	<0.000048	0.000048	0.00020	W519088	19-May-15	U
EPA 200.8	Boron	mg/L	<0.0012	0.0012	0.0050	W519088	19-May-15	U
EPA 200.8	Cadmium	mg/L	<0.000072	0.000072	0.00020	W519088	19-May-15	U
EPA 200.8	Chromium	mg/L	<0.0004	0.0004	0.0015	W519088	19-May-15	U
EPA 200.8	Cobalt	mg/L	<0.000054	0.000054	0.00100	W519088	19-May-15	U
EPA 200.8	Copper	mg/L	<0.00015	0.00015	0.00100	W519088	19-May-15	U
EPA 200.8	Lead	mg/L	<0.000031	0.000031	0.00300	W519088	19-May-15	U
EPA 200.8	Manganese	mg/L	<0.000025	0.000025	0.00100	W519088	19-May-15	U
EPA 200.8	Molybdenum	mg/L	<0.00009	0.00009	0.00100	W519088	19-May-15	U
EPA 200.8	Nickel	mg/L	<0.0004	0.0004	0.0010	W519088	19-May-15	U
EPA 200.8	Selenium	mg/L	<0.0006	0.0006	0.0030	W519088	19-May-15	U
EPA 200.8	Silver	mg/L	<0.000021	0.000021	0.000100	W519088	19-May-15	U
EPA 200.8	Thallium	mg/L	<0.000026	0.000026	0.00100	W519088	19-May-15	U
EPA 200.8	Uranium	mg/L	<0.000014	0.000014	0.00100	W519088	19-May-15	U
EPA 200.8	Vanadium	mg/L	<0.0009	0.0009	0.0030	W519088	19-May-15	U
EPA 200.8	Zinc	mg/L	<0.0010	0.0010	0.0050	W519088	19-May-15	U
<b>Metals (Filtered)</b>								
EPA 245.1	Mercury	mg/L	<0.00004	0.00004	0.00020	W520309	20-May-15	U
<b>Classical Chemistry Parameters</b>								
SM 2320B	Total Alkalinity	mg/L as CaCO <sub>3</sub>	0.76		1.0	W520293	20-May-15	J
SM 2320B	Bicarbonate	mg/L as CaCO <sub>3</sub>	0.76		1.0	W520293	20-May-15	J
SM 2320B	Carbonate	mg/L as CaCO <sub>3</sub>	0		1.0	W520293	20-May-15	U
SM 2320B	Hydroxide	mg/L as CaCO <sub>3</sub>	0		1.0	W520293	20-May-15	U
SM 2540 C	Total Diss. Solids	mg/L	<10		10	W520262	15-May-15	
SM 4500-CN-I	Cyanide (WAD)	mg/L	<0.0025	0.0025	0.0100	W521183	21-May-15	U
SM 4500-P-E	Orthophosphate as P	mg/L	<0.006	0.006	0.010	W520289	15-May-15	U
SM 4500-S-F	Sulfide	mg/L	<0.39	0.39	1.00	W521066	19-May-15	U
SM 5310B	Total Organic Carbon	mg/L	<0.24	0.24	1.00	W521129	21-May-15	U
<b>Anions by Ion Chromatography</b>								
EPA 300.0	Chloride	mg/L	<0.06	0.06	0.20	W520249	15-May-15	U
EPA 300.0	Fluoride	mg/L	<0.022	0.022	0.100	W520249	15-May-15	U
EPA 300.0	Nitrate as N	mg/L	<0.008	0.008	0.050	W520249	15-May-15	U
EPA 300.0	Nitrite as N	mg/L	<0.014	0.014	0.050	W520249	15-May-15	U
EPA 300.0	Sulfate as SO <sub>4</sub>	mg/L	<0.05	0.05	0.30	W520249	15-May-15	U



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

**Quality Control - LABORATORY CONTROL SAMPLE Data**

Method	Analyte	Units	LCS Result	LCS True	% Rec.	Acceptance Limits	Batch ID	Analyzed	Notes
<b>Metals (Dissolved)</b>									
EPA 200.7	Aluminum	mg/L	0.94	1.00	94.5	85 - 115	W520254	29-May-15	
EPA 200.7	Calcium	mg/L	18.8	20.0	93.8	85 - 115	W520254	29-May-15	
EPA 200.7	Iron	mg/L	9.09	10.0	90.9	85 - 115	W520254	29-May-15	
EPA 200.7	Magnesium	mg/L	18.5	20.0	92.5	85 - 115	W520254	29-May-15	
EPA 200.7	Potassium	mg/L	19.0	20.0	94.8	85 - 115	W520254	29-May-15	
EPA 200.7	Silica (SiO2)	mg/L	10.3	10.7	96.4	85 - 115	W520254	29-May-15	B7
EPA 200.7	Sodium	mg/L	17.4	19.0	91.3	85 - 115	W520254	29-May-15	
EPA 200.8	Antimony	mg/L	0.0257	0.0250	103	85 - 115	W519088	19-May-15	
EPA 200.8	Arsenic	mg/L	0.0272	0.0250	109	85 - 115	W519088	19-May-15	
EPA 200.8	Barium	mg/L	0.0269	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Beryllium	mg/L	0.0269	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Boron	mg/L	0.0266	0.0250	106	85 - 115	W519088	19-May-15	
EPA 200.8	Cadmium	mg/L	0.0280	0.0250	112	85 - 115	W519088	19-May-15	
EPA 200.8	Chromium	mg/L	0.0264	0.0250	106	85 - 115	W519088	19-May-15	
EPA 200.8	Cobalt	mg/L	0.0266	0.0250	106	85 - 115	W519088	19-May-15	
EPA 200.8	Copper	mg/L	0.0271	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Lead	mg/L	0.0267	0.0250	107	85 - 115	W519088	19-May-15	
EPA 200.8	Manganese	mg/L	0.0269	0.0250	107	85 - 115	W519088	19-May-15	
EPA 200.8	Molybdenum	mg/L	0.0269	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Nickel	mg/L	0.0261	0.0250	104	85 - 115	W519088	19-May-15	
EPA 200.8	Selenium	mg/L	0.0281	0.0250	112	85 - 115	W519088	19-May-15	
EPA 200.8	Silver	mg/L	0.0270	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Thallium	mg/L	0.0266	0.0250	107	85 - 115	W519088	19-May-15	
EPA 200.8	Uranium	mg/L	0.0261	0.0250	104	85 - 115	W519088	19-May-15	
EPA 200.8	Vanadium	mg/L	0.0269	0.0250	108	85 - 115	W519088	19-May-15	
EPA 200.8	Zinc	mg/L	0.0284	0.0250	114	85 - 115	W519088	19-May-15	
<b>Metals (Filtered)</b>									
EPA 245.1	Mercury	mg/L	0.00474	0.00500	94.8	85 - 115	W520309	20-May-15	
<b>Classical Chemistry Parameters</b>									
SM 2320B	Total Alkalinity	mg/L as CaCO3	101	99.3	102	85 - 115	W520293	20-May-15	
SM 2320B	Bicarbonate	mg/L as CaCO3	101	99.3	102	85 - 115	W520293	20-May-15	
SM 2510 B	Specific conductance	µmhos/cm	316	306	103	90 - 110	W520271	15-May-15	
SM 4500-CN-I	Cyanide (WAD)	mg/L	0.154	0.150	103	90 - 110	W521183	21-May-15	
SM 4500-P-E	Orthophosphate as P	mg/L	0.739	0.786	94.0	90 - 110	W520289	15-May-15	
SM 4500-S-F	Sulfide	mg/L	2.49	2.50	99.8	80 - 120	W521066	19-May-15	
SM 5310B	Total Organic Carbon	mg/L	34.6	34.3	101	90 - 110	W521129	21-May-15	
<b>Anions by Ion Chromatography</b>									
EPA 300.0	Chloride	mg/L	2.97	3.00	99.1	90 - 110	W520249	15-May-15	
EPA 300.0	Fluoride	mg/L	1.93	2.00	96.6	90 - 110	W520249	15-May-15	
EPA 300.0	Nitrate as N	mg/L	1.97	2.01	98.1	90 - 110	W520249	15-May-15	
EPA 300.0	Nitrite as N	mg/L	2.56	2.51	102	90 - 110	W520249	15-May-15	
EPA 300.0	Sulfate as SO4	mg/L	9.75	10.0	97.5	90 - 110	W520249	15-May-15	



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

**Quality Control - DUPLICATE Data**

Method	Analyte	Units	Duplicate Result	Sample Result	RPD	RPD Limit	Batch ID	Analyzed	Notes
<b>Classical Chemistry Parameters</b>									
SM 2320B	Total Alkalinity	mg/L as CaCO <sub>3</sub>	178	180	1.0	20	W520293	20-May-15	
SM 2320B	Bicarbonate	mg/L as CaCO <sub>3</sub>	178	180	1.0	20	W520293	20-May-15	
SM 2320B	Carbonate	mg/L as CaCO <sub>3</sub>	0	0.00	UDL	20	W520293	20-May-15	U
SM 2320B	Hydroxide	mg/L as CaCO <sub>3</sub>	0	0.00	UDL	20	W520293	20-May-15	U
SM 2510 B	Specific conductance	µmhos/cm	438	436	0.5	20	W520271	15-May-15	
SM 2540 C	Total Diss. Solids	mg/L	551	557	1.1	10	W520262	15-May-15	
SM 2540 C	Total Diss. Solids	mg/L	552	555	0.5	10	W520262	15-May-15	
SM 4500 H B	pH	pH Units	7.95	8.02	0.9	20	W520293	20-May-15	

**Quality Control - MATRIX SPIKE Data**

Method	Analyte	Units	Spike Result	Sample Result (R)	Spike Level (S)	% Rec.	Acceptance Limits	Batch ID	Analyzed	Notes
<b>Metals (Dissolved)</b>										
EPA 200.7	Aluminum	mg/L	1.05	0.07	1.00	98.6	70 - 130	W520254	29-May-15	
EPA 200.7	Aluminum	mg/L	0.95	<0.036	1.00	95.5	70 - 130	W520254	29-May-15	
EPA 200.7	Calcium	mg/L	308	290	20.0	89.9	70 - 130	W520254	29-May-15	
EPA 200.7	Calcium	mg/L	139	121	20.0	87.3	70 - 130	W520254	29-May-15	
EPA 200.7	Iron	mg/L	9.30	<0.026	10.0	93.0	70 - 130	W520254	29-May-15	
EPA 200.7	Iron	mg/L	9.50	<0.026	10.0	95.0	70 - 130	W520254	29-May-15	
EPA 200.7	Magnesium	mg/L	47.9	29.1	20.0	94.0	70 - 130	W520254	29-May-15	
EPA 200.7	Magnesium	mg/L	32.4	13.8	20.0	93.1	70 - 130	W520254	29-May-15	
EPA 200.7	Potassium	mg/L	37.8	17.8	20.0	99.9	70 - 130	W520254	29-May-15	
EPA 200.7	Potassium	mg/L	21.6	2.03	20.0	97.8	70 - 130	W520254	29-May-15	
EPA 200.7	Silica (SiO <sub>2</sub> )	mg/L	44.3	33.4	10.7	102	70 - 130	W520254	29-May-15	B7
EPA 200.7	Silica (SiO <sub>2</sub> )	mg/L	53.8	43.6	10.7	94.6	70 - 130	W520254	29-May-15	B7
EPA 200.7	Sodium	mg/L	162	144	19.0	93.2	70 - 130	W520254	29-May-15	
EPA 200.7	Sodium	mg/L	45.3	27.8	19.0	91.9	70 - 130	W520254	29-May-15	
EPA 200.8	Antimony	mg/L	0.0248	0.00041	0.0250	97.6	70 - 130	W519088	19-May-15	
EPA 200.8	Arsenic	mg/L	0.0302	0.00036	0.0250	119	70 - 130	W519088	19-May-15	
EPA 200.8	Barium	mg/L	0.0678	0.0436	0.0250	96.7	70 - 130	W519088	19-May-15	
EPA 200.8	Beryllium	mg/L	0.0267	<0.000048	0.0250	107	70 - 130	W519088	19-May-15	
EPA 200.8	Boron	mg/L	0.113	0.0902	0.0250	92.1	70 - 130	W519088	19-May-15	
EPA 200.8	Cadmium	mg/L	0.0269	<0.000072	0.0250	108	70 - 130	W519088	19-May-15	
EPA 200.8	Chromium	mg/L	0.0288	0.0033	0.0250	102	70 - 130	W519088	19-May-15	
EPA 200.8	Cobalt	mg/L	0.0264	0.00089	0.0250	102	70 - 130	W519088	19-May-15	
EPA 200.8	Copper	mg/L	0.0256	0.00070	0.0250	99.6	70 - 130	W519088	19-May-15	
EPA 200.8	Lead	mg/L	0.0250	0.00049	0.0250	98.0	70 - 130	W519088	19-May-15	
EPA 200.8	Manganese	mg/L	0.502	0.490	0.0250	R > 4S	70 - 130	W519088	19-May-15	M3
EPA 200.8	Molybdenum	mg/L	0.0302	0.00414	0.0250	104	70 - 130	W519088	19-May-15	
EPA 200.8	Nickel	mg/L	0.0298	0.0048	0.0250	100	70 - 130	W519088	19-May-15	
EPA 200.8	Selenium	mg/L	0.0333	0.0014	0.0250	128	70 - 130	W519088	19-May-15	
EPA 200.8	Silver	mg/L	0.0248	<0.000021	0.0250	99.1	70 - 130	W519088	19-May-15	
EPA 200.8	Thallium	mg/L	0.0249	<0.000026	0.0250	99.5	70 - 130	W519088	19-May-15	
EPA 200.8	Uranium	mg/L	0.0262	0.00127	0.0250	99.7	70 - 130	W519088	19-May-15	
EPA 200.8	Vanadium	mg/L	0.0277	0.0013	0.0250	106	70 - 130	W519088	19-May-15	
EPA 200.8	Zinc	mg/L	0.0336	0.0057	0.0250	111	70 - 130	W519088	19-May-15	

**Metals (Filtered)**

EPA 245.1	Mercury	mg/L	0.00098	<0.00004	0.00100	98.0	70 - 130	W520309	20-May-15	
EPA 245.1	Mercury	mg/L	0.00102	0.00006	0.00100	96.0	70 - 130	W520309	20-May-15	

**Classical Chemistry Parameters**

SM 4500-CN-I	Cyanide (WAD)	mg/L	0.0930	<0.0025	0.100	93.0	75 - 125	W521183	21-May-15	
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SVL holds the following certifications:

AZ:0538, CA:2080, FL(NELAC):E87993, ID:ID00019 &amp; ID00965 (Microbiology), NV:ID000192007A, WA:C573

Work order Report Page 6 of 8



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**  
Work Order: **WSE0290**  
Reported: 09-Jun-15 17:47

**Quality Control - MATRIX SPIKE Data (Continued)**

Method	Analyte	Units	Spike Result	Sample Result (R)	Spike Level (S)	% Rec.	Acceptance Limits	Batch ID	Analyzed	Notes
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**Classical Chemistry Parameters (Continued)**

SM 4500-P-E	Orthophosphate as P	mg/L	0.513	0.016	0.500	99.5	75 - 125	W520289	15-May-15	
SM 4500-S-F	Sulfide	mg/L	2.74	0.48	2.50	90.1	80 - 120	W521066	19-May-15	
SM 5310B	Total Organic Carbon	mg/L	51.5	<0.24	50.0	103	80 - 120	W521129	21-May-15	

**Anions by Ion Chromatography**

EPA 300.0	Chloride	mg/L	61.7	59.7	3.00	R > 4S	90 - 110	W520249	15-May-15	D2,M3
EPA 300.0	Chloride	mg/L	28.9	25.6	3.00	109	90 - 110	W520249	18-May-15	D2,M3
EPA 300.0	Fluoride	mg/L	2.23	0.311	2.00	96.1	90 - 110	W520249	15-May-15	
EPA 300.0	Fluoride	mg/L	2.21	0.224	2.00	99.1	90 - 110	W520249	15-May-15	
EPA 300.0	Nitrate as N	mg/L	4.96	2.76	2.00	110	90 - 110	W520249	15-May-15	
EPA 300.0	Nitrate as N	mg/L	3.55	1.39	2.00	108	90 - 110	W520249	15-May-15	
EPA 300.0	Nitrite as N	mg/L	2.65	<0.014	2.00	133	90 - 110	W520249	15-May-15	M1
EPA 300.0	Nitrite as N	mg/L	1.94	<0.014	2.00	97.0	90 - 110	W520249	15-May-15	
EPA 300.0	Sulfate as SO4	mg/L	63.6	53.2	10.0	105	90 - 110	W520249	15-May-15	D2,M3
EPA 300.0	Sulfate as SO4	mg/L	58.9	49.7	10.0	92.2	90 - 110	W520249	18-May-15	D2,M3

**Quality Control - MATRIX SPIKE DUPLICATE Data**

Method	Analyte	Units	MSD Result	Spike Result	Spike Level	%R	RPD	RPD Limit	Batch ID	Analyzed	Notes
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**Metals (Dissolved)**

EPA 200.7	Aluminum	mg/L	1.05	1.05	1.00	98.1	0.5	20	W520254	29-May-15	
EPA 200.7	Calcium	mg/L	309	308	20.0	95.0	0.3	20	W520254	29-May-15	
EPA 200.7	Iron	mg/L	9.30	9.30	10.0	93.0	0.0	20	W520254	29-May-15	
EPA 200.7	Magnesium	mg/L	47.8	47.9	20.0	93.4	0.3	20	W520254	29-May-15	
EPA 200.7	Potassium	mg/L	37.9	37.8	20.0	100	0.2	20	W520254	29-May-15	
EPA 200.7	Silica (SiO2)	mg/L	44.2	44.3	10.7	101	0.3	20	W520254	29-May-15	B7
EPA 200.7	Sodium	mg/L	162	162	19.0	91.1	0.2	20	W520254	29-May-15	
EPA 200.8	Antimony	mg/L	0.0260	0.0248	0.0250	102	4.6	20	W519088	19-May-15	
EPA 200.8	Arsenic	mg/L	0.0305	0.0302	0.0250	120	0.8	20	W519088	19-May-15	
EPA 200.8	Barium	mg/L	0.0701	0.0678	0.0250	106	3.4	20	W519088	19-May-15	
EPA 200.8	Beryllium	mg/L	0.0269	0.0267	0.0250	107	0.7	20	W519088	19-May-15	
EPA 200.8	Boron	mg/L	0.114	0.113	0.0250	93.3	0.3	20	W519088	19-May-15	
EPA 200.8	Cadmium	mg/L	0.0275	0.0269	0.0250	110	2.1	20	W519088	19-May-15	
EPA 200.8	Chromium	mg/L	0.0298	0.0288	0.0250	106	3.3	20	W519088	19-May-15	
EPA 200.8	Cobalt	mg/L	0.0268	0.0264	0.0250	104	1.6	20	W519088	19-May-15	
EPA 200.8	Copper	mg/L	0.0262	0.0256	0.0250	102	2.2	20	W519088	19-May-15	
EPA 200.8	Lead	mg/L	0.0252	0.0250	0.0250	99.0	1.1	20	W519088	19-May-15	
EPA 200.8	Manganese	mg/L	0.515	0.502	0.0250	100	2.7	20	W519088	19-May-15	M3
EPA 200.8	Molybdenum	mg/L	0.0307	0.0302	0.0250	106	1.4	20	W519088	19-May-15	
EPA 200.8	Nickel	mg/L	0.0301	0.0298	0.0250	101	1.3	20	W519088	19-May-15	
EPA 200.8	Selenium	mg/L	0.0326	0.0333	0.0250	125	2.3	20	W519088	19-May-15	
EPA 200.8	Silver	mg/L	0.0249	0.0248	0.0250	99.7	0.6	20	W519088	19-May-15	
EPA 200.8	Thallium	mg/L	0.0251	0.0249	0.0250	100	0.8	20	W519088	19-May-15	
EPA 200.8	Uranium	mg/L	0.0261	0.0262	0.0250	99.3	0.4	20	W519088	19-May-15	
EPA 200.8	Vanadium	mg/L	0.0280	0.0277	0.0250	107	0.8	20	W519088	19-May-15	
EPA 200.8	Zinc	mg/L	0.0355	0.0336	0.0250	119	5.5	20	W519088	19-May-15	

**Metals (Filtered)**

EPA 245.1	Mercury	mg/L	0.00099	0.00098	0.00100	99.0	1.0	20	W520309	20-May-15	
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**Classical Chemistry Parameters**

SM 4500-CN-I	Cyanide (WAD)	mg/L	0.0900	0.0930	0.100	90.0	3.3	20	W521183	21-May-15	
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SVL holds the following certifications:

AZ:0538, CA:2080, FL(NELAC):E87993, ID:ID00019 & ID00965 (Microbiology), NV:ID000192007A, WA:C573



Excelsior Mining Corp.  
2999 N. 44th St. #300  
Phoenix, AZ 85018

**Project Name: Gunnison Copper 2015**

Work Order: **W5E0290**

Reported: 09-Jun-15 17:47

**Quality Control - MATRIX SPIKE DUPLICATE Data (Continued)**

Method	Analyte	Units	MSD Result	Spike Result	Spike Level	%R	RPD	RPD Limit	Batch ID	Analyzed	Notes
<b>Classical Chemistry Parameters (Continued)</b>											
SM 4500-P-E	Orthophosphate as P	mg/L	0.511	0.513	0.500	99.1	0.4	20	W520289	15-May-15	
SM 4500-S-F	Sulfide	mg/L	2.66	2.74	2.50	86.9	3.0	20	W521066	19-May-15	
SM 5310B	Total Organic Carbon	mg/L	51.3	51.5	50.0	103	0.4	20	W521129	21-May-15	
<b>Anions by Ion Chromatography</b>											
EPA 300.0	Chloride	mg/L	62.3	61.7	3.00	R > 4S	1.0	20	W520249	15-May-15	D2,M3
EPA 300.0	Fluoride	mg/L	2.26	2.23	2.00	97.5	1.2	20	W520249	15-May-15	
EPA 300.0	Nitrate as N	mg/L	5.01	4.96	2.00	113	1.1	20	W520249	15-May-15	M1
EPA 300.0	Nitrite as N	mg/L	2.69	2.65	2.00	134	1.2	20	W520249	15-May-15	M1
EPA 300.0	Sulfate as SO4	mg/L	64.2	63.6	10.0	R > 4S	0.9	20	W520249	15-May-15	D2,M3

**Notes and Definitions**

B7	Target analyte detected in method blank exceeded method QC limits, but concentrations in the samples are at least 10x the blank concentration.
D2	Sample required dilution due to high concentration of target analyte.
H5	This test is specified to be performed in the field within 15 minutes of sampling; sample was received and analyzed past the regulatory holding time.
J	The reported value is less than the Reporting Limit (MRL, CRDL) but greater than or equal to the MDL. Results closer to the MDL have increased relative uncertainty.
M1	Matrix spike recovery was high, but the LCS recovery was acceptable.
M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to spike level. The LCS was acceptable.
U	Less than MDL.
LCS	Laboratory Control Sample (Blank Spike)
RPD	Relative Percent Difference
UDL	A result is less than the detection limit
R > 4S	% recovery not applicable, sample concentration more than four times greater than spike level
<RL	A result is less than the reporting limit
MRL	Method Reporting Limit
MDL	Method Detection Limit
N/A	Not Applicable

Tuesday, June 16, 2015

Chris Meyer  
SVL Analytical  
One Government Gulch  
Kellogg, ID 83837-0929

Re: ALS Workorder: 1505347  
Project Name:  
Project Number: 5E0290

Dear Ms. Meyer:

One water sample was received from SVL Analytical, on 5/19/2015. The sample was scheduled for the following analyses:

Gross Alpha/Beta

Isotopic Uranium

Radium-226

Radium-228

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,



ALS Environmental  
Jeff R. Kujawa  
Project Manager



ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New Jersey (NJ)	CO003
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280



**1505347**

**Gross Alpha/Beta:**

The sample was analyzed for gross alpha and beta activity by gas flow proportional counting according to the current revision of SOP 724. Gross alpha results are referenced to  $^{241}\text{Am}$ . Gross beta results are referenced to  $^{90}\text{Sr/Y}$ .

All acceptance criteria were met with the following exception:

Gross alpha/beta activity is reported in the associated method blank above the minimum detectable concentration value. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.

**Radium-228:**

The sample was analyzed for the presence of  $^{228}\text{Ra}$  by low background gas flow proportional counting of  $^{228}\text{Ac}$ , which is the ingrown progeny of  $^{228}\text{Ra}$ , according to the current revision of SOP 724.

All acceptance criteria were met.

**Radium-226:**

The sample was prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

**Isotopic Uranium:**

The sample was analyzed for the presence of isotopic uranium according to the current revision of SOP 714.

All acceptance criteria were met with the following exception:

Uranium-235 activity is reported in the associated method blank above the minimum detectable concentration value. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.

# ALS Environmental -- FC

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1505347

**Client Name:** SVL Analytical

**Client Project Name:**

**Client Project Number:** 5E0290

**Client PO Number:** 15322

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
NSH-006-051315	1505347-1		WATER	13-May-15	14:05

ALS

1505347

Page 1 of 1

## CHAIN OF CUSTODY RECORD

SVL Analytical, Inc. • One Government Gulch • Kellogg, ID 83837 • (208) 784-1258 • FAX: (208) 783-0891



Report to Company: SVL Analytical  
 Contact: Chris Meyer  
 Address: Government Gulch  
Kellogg ID 83837  
 Phone Number: 208-784-1258  
 FAX Number: 208-783-0891  
 E-mail: \_\_\_\_\_

Invoice Sent To: \_\_\_\_\_  
 Contact: Same  
 Address: \_\_\_\_\_  
 Phone Number: \_\_\_\_\_  
 FAX Number: \_\_\_\_\_  
 PO#: 15322

Indicate State of sample origination: AZProject Name: Excelsior

Sampler's Signature: \_\_\_\_\_

Sample ID	Collection		Misc.	Preservative(s)					Other (Specify)	Analyses Required	Rush Instructions (Days)	Comments	
	Date	Time		Collected by: (init.)	Matrix Type (From Table 1)	No. of Containers	Unpreserved	HNO <sub>3</sub> Filtered					HNO <sub>3</sub> Unfiltered
1 NSH-006-051315	5/13/15	1405	2	3									
2													
3													
4													
5													
6													
7													
8													
9													
10													

Please take care to distinguish between:  
 1 and I  
 2 and Z  
 5 and S  
 0 and O  
 Thanks!

Relinquished by: SVL Analytical  
 Relinquished by: Chris Meyer  
 Date: 5/14/15 Time: 1350  
 Received by: En Pata  
 Received by: En Pata  
 Date: 5/19/15 Time: 1120

\* Sample Reject:

☐ Return☐ Dispose☐ Store (30 Days)

White: LAB COPY Yellow: CUSTOMER COPY

SVL-COC 01/14



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: SVL  
Project Manager: JRK

Workorder No: 1505347  
Initials: ECP Date: 5/19/15

1. Does this project require any special handling in addition to standard ALS procedures?		YES	<input checked="" type="radio"/> NO
2. Are custody seals on shipping containers intact?	NONE	<input checked="" type="radio"/> YES	NO
3. Are Custody seals on sample containers intact?	<input checked="" type="radio"/> NONE	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		<input checked="" type="radio"/> YES	NO
5. Are the COC and bottle labels complete and legible?		<input checked="" type="radio"/> YES	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		<input checked="" type="radio"/> YES	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	<input checked="" type="radio"/> YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	<input checked="" type="radio"/> YES	NO
9. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> N/A	YES	NO
10. Is there sufficient sample for the requested analyses?		<input checked="" type="radio"/> YES	NO
11. Were all samples placed in the proper containers for the requested analyses?		<input checked="" type="radio"/> YES	NO
12. Are all samples within holding times for the requested analyses?		<input checked="" type="radio"/> YES	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		<input checked="" type="radio"/> YES	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: _____ < green pea _____ > green pea	<input checked="" type="radio"/> N/A	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: _____ dusting _____ moderate _____ heavy	N/A	YES	<input checked="" type="radio"/> NO
16. Were the samples shipped on ice?		YES	<input checked="" type="radio"/> NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	<input checked="" type="radio"/> RAD ONLY	YES	<input checked="" type="radio"/> NO
Cooler #: <u>1</u>			
Temperature (°C): <u>AMB</u>			
No. of custody seals on cooler: <u>1</u>			
External µR/hr reading: <u>10</u>			
Background µR/hr reading: <u>11</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? <input checked="" type="radio"/> YES <input type="radio"/> NO <input type="radio"/> NA (If no, see Form 008.)			

**Additional Information:** PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO ☒ NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: [Signature] 5-19-15

1505347

SHIPPING  
(208) 784-1258  
SVL ANALYTICAL  
1 GOVERNMENT GULCH  
KELLOGG ID 83837

12 LBS

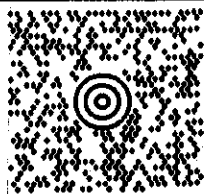
1 OF 1

DWT: 14,11,16

SHIP TO:

ALS  
225 COMMERCE DRIVE  
FORT COLLINS CO 80524-2762

10  
-1

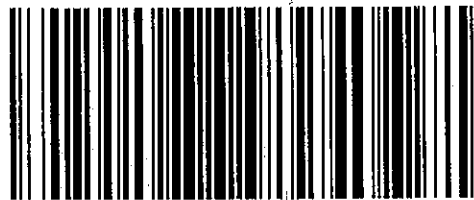


CO 805 0-01



UPS GROUND

TRACKING #: 1Z 9X8 989 03 4581 6290



BILLING: P/P

Description: SUB-CONTRACT

US 16.0.31

63.0A.04/2015



SEE NOTICE ON REVERSE regarding UPS Terms, and notice of limitation of liability. Where allowed by law, shipper authorizes UPS to act as forwarding agent for export control and customs purposes. If exported from the US, shipper certifies that the commodities, technology or software were exported from the US in accordance with the Export Administration Regulations. Diversion contrary to law is prohibited.

800 R 0215



**Client:** SVL Analytical  
**Project:** 5E0290  
**Sample ID:** NSH-006-051315  
**Legal Location:**  
**Collection Date:** 5/13/2015 14:05

**Date:** 16-Jun-15  
**Work Order:** 1505347  
**Lab ID:** 1505347-1  
**Matrix:** WATER  
**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Gross Alpha/Beta by GFPC</b>						
			<b>PAI 724</b>		Prep Date: <b>6/9/2015</b>	PrepBy: <b>DKL</b>
GROSS ALPHA	2.6 (+/- 1.2)	LT	1.8	pCi/l	NA	6/11/2015 15:09
GROSS BETA	3.3 (+/- 1.4)	LT	2.6	pCi/l	NA	6/11/2015 15:09
<b>Isotopic Uranium by Alpha Spectroscopy</b>						
			<b>PAI 714</b>		Prep Date: <b>6/9/2015</b>	PrepBy: <b>TDE</b>
Tracer: U-232	93.1		30-110	%REC	DL = NA	6/11/2015 14:26
<b>U-234</b>	<b>1.51 (+/- 0.34)</b>		<b>0.08</b>	<b>pCi/l</b>	NA	6/11/2015 14:26
U-235	ND (+/- 0.048)	U	0.069	pCi/l	NA	6/11/2015 14:26
<b>U-238</b>	<b>1.26 (+/- 0.29)</b>		<b>0.06</b>	<b>pCi/l</b>	NA	6/11/2015 14:26
<b>Radium-226 by Radon Emanation - Method 903.1</b>						
			<b>PAI 783</b>		Prep Date: <b>6/2/2015</b>	PrepBy: <b>PJW</b>
Ra-226	0.43 (+/- 0.2)	LT	0.17	pCi/l	NA	6/9/2015 13:50
Carr: BARIUM	93.7		40-110	%REC	DL = NA	6/9/2015 13:50
<b>Radium-228 Analysis by GFPC</b>						
			<b>PAI 724</b>		Prep Date: <b>5/27/2015</b>	PrepBy: <b>DKL</b>
Ra-228	ND (+/- 0.21)	U	0.43	pCi/l	NA	6/2/2015 08:35
Carr: BARIUM	93.7		40-110	%REC	DL = NA	6/2/2015 08:35

**Client:** SVL Analytical  
**Project:** 5E0290  
**Sample ID:** NSH-006-051315  
**Legal Location:**  
**Collection Date:** 5/13/2015 14:05

**Date:** 16-Jun-15  
**Work Order:** 1505347  
**Lab ID:** 1505347-1  
**Matrix:** WATER  
**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
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### Explanation of Qualifiers

#### Radiochemistry:

U or ND - Result is less than the sample specific MDC.  
 Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
 Y2 - Chemical Yield outside default limits.  
 W - DER is greater than Warning Limit of 1.42  
 \* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.  
 # - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.  
 G - Sample density differs by more than 15% of LCS density.  
 D - DER is greater than Control Limit  
 M - Requested MDC not met.  
 LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
 L - LCS Recovery below lower control limit.  
 H - LCS Recovery above upper control limit.  
 P - LCS, Matrix Spike Recovery within control limits.  
 N - Matrix Spike Recovery outside control limits  
 NC - Not Calculated for duplicate results less than 5 times MDC  
 B - Analyte concentration greater than MDC.  
 B3 - Analyte concentration greater than MDC but less than Requested MDC.

#### Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).  
 U or ND - Indicates that the compound was analyzed for but not detected.  
 E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.  
 M - Duplicate injection precision was not met.  
 N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.  
 Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.  
 \* - Duplicate analysis (relative percent difference) not within control limits.  
 S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

#### Organics:

U or ND - Indicates that the compound was analyzed for but not detected.  
 B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.  
 E - Analyte concentration exceeds the upper level of the calibration range.  
 J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).  
 A - A tentatively identified compound is a suspected aldol-condensation product.  
 X - The analyte was diluted below an accurate quantitation level.  
 \* - The spike recovery is equal to or outside the control criteria used.  
 + - The relative percent difference (RPD) equals or exceeds the control criteria.  
 G - A pattern resembling gasoline was detected in this sample.  
 D - A pattern resembling diesel was detected in this sample.  
 M - A pattern resembling motor oil was detected in this sample.  
 C - A pattern resembling crude oil was detected in this sample.  
 4 - A pattern resembling JP-4 was detected in this sample.  
 5 - A pattern resembling JP-5 was detected in this sample.  
 H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.  
 L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.  
 Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:  
 - gasoline  
 - JP-8  
 - diesel  
 - mineral spirits  
 - motor oil  
 - Stoddard solvent  
 - bunker C



## ALS Environmental -- FC

Client: SVL Analytical

Work Order: 1505347

Project: 5E0290

Date: 6/16/2015 3:11:

## QC BATCH REPORT

Batch ID: RE150602-2-1

Instrument ID Alpha Scin

Method: Radium-226 by Radon Emanation

LCS	Sample ID: RE150602-2				Units: pCi/l		Analysis Date: 6/9/2015 14:30				
Client ID:	Run ID: RE150602-2A				Prep Date: 6/2/2015			DF: NA			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	25.9 (+/- 6.6)	0.2	30.71		84.4	67-120					P
Carr: BARIUM	31790		34340		92.6	40-110					

MB	Sample ID: RE150602-2				Units: pCi/l			Analysis Date: 6/9/2015 14:30			
Client ID:	Run ID: RE150602-2A				Prep Date: 6/2/2015			DF: NA			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	ND	0.144									U
Carr: BARIUM	31550		34340		91.9	40-110					

The following samples were analyzed in this batch:

1505347-1

Client: SVL Analytical  
Work Order: 1505347  
Project: 5E0290

## QC BATCH REPORT

Batch ID: **AS150609-2-3** Instrument ID **AlphaSpec2** Method: **Isotopic Uranium by Alpha Spec**

LCS	Sample ID: AS150609-2			Units: pCi/l			Analysis Date: 6/12/2015 07:50				
Client ID:	Run ID: AS150609-2U			Prep Date: 6/9/2015			DF: NA				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
U-234	4.88 (+/- 0.85)	0.04	4.416		111	82-122					P
U-238	5.29 (+/- 0.92)	0.03	4.585		115	78-126					P
Tracer: U-232	3.63	0.05	4.164		87.3	30-110					

MB	Sample ID: AS150609-2			Units: pCi/l			Analysis Date: 6/12/2015 07:50				
Client ID:		Run ID: AS150609-2U			Prep Date: 6/9/2015			DF: NA			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
U-234	ND	0.03									U
U-235	0.016 (+/- 0.02)	0.014									B3
U-238	ND	0.03									U
Tracer: U-232	3.66	0.04	4.164		87.8	30-110					

The following samples were analyzed in this batch:

1505347-1

**Client:** SVL Analytical  
**Work Order:** 1505347  
**Project:** 5E0290

## QC BATCH REPORT

Batch ID: **AB150609-1-2** Instrument ID **LB4100-C** Method: **Gross Alpha/Beta by GFPC**

<b>LCS</b>		Sample ID: <b>AB150609-1</b>			Units: <b>pCi/l</b>			Analysis Date: <b>6/11/2015 14:24</b>			
Client ID:		Run ID: <b>AB150609-1A</b>			Prep Date: <b>6/9/2015</b>			DF: <b>NA</b>			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	237 (+/- 43)	6	224.2		106	70-130					P,M3
GROSS BETA	214 (+/- 37)	12	203.5		105	70-130					P,M3

<b>MB</b>		Sample ID: <b>AB150609-1</b>			Units: <b>pCi/l</b>			Analysis Date: <b>6/11/2015 14:33</b>			
Client ID:		Run ID: <b>AB150609-1A</b>			Prep Date: <b>6/9/2015</b>			DF: <b>NA</b>			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	1.05 (+/- 0.47)	0.66									B3
GROSS BETA	1.21 (+/- 0.69)	1.06									B3

The following samples were analyzed in this batch:

1505347-1

**Client:** SVL Analytical  
**Work Order:** 1505347  
**Project:** 5E0290

## QC BATCH REPORT

Batch ID: **RA150527-1-2** Instrument ID **LB4100-A** Method: **Radium-228 Analysis by GFPC**

<b>LCS</b>		Sample ID: <b>RA150527-1</b>			Units: <b>pCi/l</b>			Analysis Date: <b>6/2/2015 08:46</b>			
Client ID:		Run ID: <b>RA150527-1A</b>			Prep Date: <b>5/27/2015</b>			DF: <b>NA</b>			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-228	8.1 (+/- 1.9)	0.5	7.743		105	70-130					P
Carr: BARIUM	31790		34340		92.6	40-110					

<b>MB</b>		Sample ID: <b>RA150527-1</b>			Units: <b>pCi/l</b>			Analysis Date: <b>6/2/2015 09:03</b>			
Client ID:		Run ID: <b>RA150527-1A</b>			Prep Date: <b>5/27/2015</b>			DF: <b>NA</b>			
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-228	ND	0.57									U
Carr: BARIUM	31550		34340		91.9	40-110					

The following samples were analyzed in this batch:

1505347-1

**EXHIBIT 1B**

**GROUNDWATER FIELD PARAMETERS**

PUMPING TEST  
FIELD DATA LOG

Project Name: EXCELSIOR	Project No.: 38681	Transducer SN: 387888
Well No.: NSH-006	Start Date: 05-11-15	Transducer type: Level Trill 500
Location: NA	Measuring Point: TBP of 1" PVC (1.97' a/s)	Transducer depth: ~660 Ft
Total Depth of Well (ft bls): 680	Screen Interval (ft bls): 640-680 FT	STATIC WATER LEVEL 655.41 #BMP on 5/8/15
Pump Type/Setting (ft bls): 667 Ft	Personnel & Company:	
How Q Measured: EM FLOW METER - PROPELLER F.M.	H.A. KFORB	

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals) (Tot 2)							
05-11-15											
1100	0	1156923.8	0	0.00	13.40	-	-	-	-	-	
1110	START PUMP										
1112	-	-	-	-							Brown, turbid, black sediment
-	ADJUST FLOW TO ~6 GPM										
1115	6.07	1156953.9	5.08	33.09	12.54	0.2	above limit	7.22	425	23.44	DO: 2.66, ORP: 119.5; Brownish orange, cloudy
-	STILL ADJUSTING GPM FLOW										
1120	6.12	1156984.4	5.02	55.94	<del>12.59</del>	0.3	above limit			23.58	Brown, turbid
1125	6.17	1157014.1	5.02	80.90	12.59	<0.1	654	7.40	435	23.79	DO: 4.77, ORP: 118.8, Brownish, cloudy
1130	6.17	1157045.1	6.30	106.94	12.57	<0.1	418	7.40	434	24.73	DO: 4.90, ORP: 123.3, Brownish, sl. cloudy
1135	6.20	1157076.5	5.19	133.08	12.62	<0.1	221	7.40	436	25.24	DO: 4.99, ORP: 125.9, Brownish, sl. cloudy
1140	6.13	1157106.9	5.19	159.04	12.56	0	83.1	7.42	437	25.37	DO: 5.24, ORP: 128.7, v. light brown, sl. cloudy
1145	6.10	1157137.6	5.19	184.74	12.59	<<0.1	48.7	7.42	439	25.58	DO: 5.31, ORP: 129.9, clear, few black speck
1150	6.10	1157168.1	5.24	210.94	12.59	0	24.7	7.45	438	25.62	DO: 5.41, ORP: 133.2, clear
1155	6.08	1157198.0	5.19	236.90	12.59	-	8.98	7.38	441	25.72	DO: 5.29, ORP: 135.0
1200	6.05	1157228.5	5.19	262.92	12.59	-	6.81	7.37	439	25.83	DO: 5.21, ORP: 134.9
1205	6.08	1157258.8	5.24	288.82	12.58	-	8.82	7.37	437	25.93	DO: 5.01, ORP: 134.9
1210	6.08	1157290.1	5.24	316.52	12.62		10.0	7.36	442	26.04	DO: 4.83, ORP: 135.2
1212	ADJUST FLOW TO ~12 GPM										
1215	12.04	1157330.9	10.66	354.40	11.62		52.7	7.37	441	26.14	DO: 4.70, ORP: 135.2
1220	12.01	1157388.1	10.78	406.05	11.51		10.6	7.36	441	26.12	DO: 4.87, ORP: 134.8
1225	11.92	1157450.5	10.60	461.90	11.53		20.5	7.37	441	25.66	DO: 5.86, ORP: 134.6
1230	11.58	1157508.3	10.70	513.78	11.48		10.5	7.38	439	25.38	DO: 5.50, ORP: 133.7
-	ADJUST FLOW										
1235	12.06	1157568.4	11.33	569.77	11.42		10.6	7.38	440	25.22	DO: 5.65, ORP: 134.0

PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: H + A : KFord		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	°C Temp. <del>99</del>	Comments
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals) (TbT2)							
5-11	-15										
1240	12.10	1157628.3	11.30	626.01	11.46		11.5	7.38	440	25.31	DO: 5.15 mg/L, ORP: 133.8
1245	12.14	1157688.8	11.30	683.80	11.42		6.39	7.39	441	25.37	DO: 5.16 mg/L, ORP: 133.5
1250	12.12	1157749.3	11.36	738.05	11.41		5.46	7.39	441	25.27	DO: 5.22 mg/L, ORP: 133.6
1255	12.11	1157810.4	11.24	797.06	11.42		8.32	7.39	441	25.30	DO: 5.29 mg/L, ORP: 133.6
1300	11.82	1157871.9	-	809.82	11.44		8.59	7.40	441	25.27	DO: 5.34 mg/L, ORP: 133.4
1305	11.83	1157929.3	-	(809.82)	11.39		6.28	7.39	440	25.20	DO: 5.24 mg/L, ORP: 134.4
1310	11.83	1157988.1	11.30	836.56	11.46		3.49	7.39	439	25.41	DO: 5.09 mg/L, ORP: 133.9
1311	ADJUST FLOW TO ~24 gpm										
1315	21.73	1158081.8									
1316	ADJUST TO 20 GPM										
1318	20.08	1158149.1	(shucked)	868.74							
1320	20.13	1158176.9	shuck	"	9.39		11.0	7.40	440	25.95	DO: 4.87 mg/L, ORP: 133.0
1324	20.16	1158277.3	19.86	893.29	9.33		16.2	7.41	441	25.64	DO: 5.03 mg/L, ORP: 133.1
1330	20.17	1158379.2	19.80	991.03	9.26		67.5	7.42	440	25.51	DO: 5.00 mg/L, ORP: 132.5
1335	20.15	1158480.2	19.80	1093.73	9.27		25.4	7.41	442	25.59	DO: 5.14 mg/L, ORP: 132.3
1340	20.23	1158580.2	19.92	1190.90	9.23		13.7	7.41	441	25.61	DO: 5.07 mg/L, ORP: 132.2
1345	20.18	1158680.8	19.86	1287.78	9.22		5.26	7.41	442	24.68	DO: 5.37 mg/L, ORP: 133.3
1350	20.23	1158781.9	19.86	1387.89	9.20		4.13	7.41	440	24.60	DO: 5.29 mg/L, ORP: 133.9
1355	20.17	1158882.5	19.86	1486.08	9.22		3.42	7.41	440	24.74	DO: 5.37 mg/L, ORP: 134.6
1400	20.19	1158983.6	19.80	1585.07	9.16		2.83	7.41	441	24.60	DO: 5.47 mg/L, ORP: 135.4
1405	20.22	1159084.6	19.92	1684.54	9.12		3.03	7.41	441	24.49	DO: 5.52 mg/L, ORP: 135.7
1410	20.14	1159185.7	19.74	1782.84	9.19		3.79	7.41	441	24.46	DO: 5.90 mg/L, ORP: 136.5
1415	20.17	1159286.6	19.80	1880.74	9.19		2.46	7.42	441	24.55	DO: 5.82 mg/L, ORP: 137.3
1420	20.21	1159387.8	19.80	1980.62	9.16		2.22	7.42	440	24.49	DO: 5.82 mg/L, ORP: 137.9
1425	20.10	1159488.7	19.68	2079.98	9.18		2.16	7.42	440	24.40	DO: 5.98 mg/L, ORP: 139.0
1430	20.14	1159592.1	19.68	2183.62	9.19		1.84	7.43	440	24.45	DO: 5.89 mg/L, ORP: 140.1
1435	20.11	1159690.1	19.80	2276.81	9.23		1.80	7.43	440	24.46	DO: 5.89 mg/L, ORP: 141.2
1440	20.26	1159791.1	19.92	2376.18	9.12		1.56	7.44	440	24.48	DO: 5.86 mg/L, ORP: 142.2
1445	20.23	1159892.1	19.97	2375.46	9.14		1.89	7.44	441	24.54	DO: 6.00 mg/L, ORP: 143.5

PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: KFORB (H.A)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	°C Temp. <del>ft</del>	Comments
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)							
5-11-15											
1450	20.16	115999.3	19.86	2574.84	9.15	-	2.37	7.44	442	24.40	DO: 6.07 mg/L ORP: 144.7
1455	20.20	116009.4	19.86	2674.50	9.13	-	3.06	7.44	442	24.39	DO: 6.06 ORP: 146.4
1500	20.22	116019.5	19.92	2772.84	9.15	-	1.24	7.45	442	24.47	DO: 6.03 ORP: 147.6
1505	20.17	116029.6	19.80	2873.00	9.15	-	1.16	7.45	442	24.46	DO: 6.04 ORP: 149.2
1510	20.17	116039.7	19.80	2972.13	9.17	-	1.18	7.45	442	24.52	DO: 6.05 ORP: 150.8
1515	20.19	116049.8	19.86	3071.38	9.12	-	1.32	7.46	441	24.56	DO: 6.01 ORP: 152.4
1520	20.29	116059.5	19.97	3170.86	9.11	-	1.84	7.47	442	24.67	DO: 6.08 ORP: 154.1
1525	20.14	116069.0	19.80	3270.10	9.11	-	1.04	7.46	443	24.70	DO: 6.07 ORP: 155.8
1530	20.24	116080.1	19.92	3368.88	9.13	-	1.26	7.47	443	24.76	DO: 6.04 ORP: 157.3
1535	20.21	116090.2	19.86	3468.51	9.12	-	1.56	7.47	444	24.78	DO: 5.21 ORP: 159.1
1540	20.17	116100.3	19.80	3567.69	9.12	-	1.45	7.47	444	24.51	DO: 5.69 ORP: 161.4
1545	20.17	116110.4	19.80	3667.44	9.13	-	1.26	7.48	443	24.47	DO: 5.47 ORP: 163.2
1550	20.20	116120.5	19.80	3765.46	9.13	-	1.38	7.48	443	24.42	DO: 5.40 ORP: 164.9
1555	20.23	116130.6	19.92	3864.93	9.10	-	2.19	7.47	443	24.37	DO: 5.73 ORP: 167.3
1600	20.16	116141.1	19.86	3969.70	9.08	-	1.45	7.48	444	24.29	DO: 5.75 ORP: 168.7
1605	20.16	116150.8	19.86	4063.66	9.14	-	1.25	7.49	444	24.35	DO: 5.63 ORP: 170.3
1610	20.19	116160.9	19.92	4163.00	9.06	-	1.10	7.49	444	24.36	DO: 5.60 ORP: 171.5
1615	20.24	116171.0	19.97	4262.29	9.11	-	1.10	7.50	444	24.39	DO: 5.55 ORP: 172.7
1620	20.21	116181.1	19.92	4361.69	9.13	-	1.35	7.49	444	24.32	DO: 5.63 ORP: 174.2
1625	20.24	116191.2	19.92	4460.73	9.10	-	0.93	7.49	444	24.34	DO: 5.61 ORP: 175.4
1630	20.15	116201.3	19.86	4561.00	9.12	-	0.85	7.50	444	24.39	DO: 5.58 ORP: 176.3
1635	20.24	116211.4	19.97	4660.16	9.07	-	1.41	7.48	444	24.29	DO: 5.79 ORP: 178.6
1640	20.11	116221.5	19.80	4759.48	9.11	-	1.18	7.50	444	24.38	DO: 5.76 ORP: 178.3
1645	20.23	116231.6	19.92	4858.31	9.09	-	0.83	7.52	444	24.37	DO: 5.69 ORP: 178.6
1650	20.26	116241.7	19.92	4957.70	9.08	-	0.76	7.52	444	24.39	DO: 5.68 ORP: 179.3
1655	20.12	116251.8	19.80	5057.23	9.14	-	1.53	7.52	444	24.39	DO: 5.76 ORP: 180.2
1700	20.23	116261.9	19.86	5155.98	9.09	-	1.20	7.53	444	24.41	DO: 5.66 ORP: 180.7
1705	20.22	116272.0	19.92	5254.74	9.08	-	1.52	7.52	444	24.33	DO: 6.17 ORP: 181.7
1710	20.26	116282.2	19.97	5354.14	9.09	-	0.80	7.52	444	24.39	DO: 6.08 ORP: 182.3



PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: KFOR (H+A), J JIMENEZ (NATIONAL)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments	
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals) (Total Z)							DO	ORP
1715	20.23	1162922.4	19.86	5454.36	9.07		1.00	7.52	444	24.31	DO: 6.14 mg/L	ORP: 183.1
1720	20.29	1163023.4	19.97	5553.28	9.10		1.27	7.52	445	24.35	DO: 6.51 mg/L	ORP: 184.1
1725	20.26	1163124.6	19.92	5652.56	9.05		1.21	7.51	444	24.36	DO: 6.55	ORP: 184.2
1730	20.15	1163225.5	19.86	5752.28	9.15		1.12	7.52	444	24.34	DO: 6.43	ORP: 184.6
1735	20.20	1163326.6	19.80	5851.86	9.07		0.73	7.54	443	24.33	DO: 6.55	ORP: 184.7
1740	20.25		19.92		9.11		0.79	7.52	445	24.36	DO: 6.54	ORP: 184.9
1800	20.24	*1163858.8	19.84	*6380.56	9.11		41.3	7.53	442	24.45	DO: 6.39	ORP: 186.2
1820	20.17		19.92		9.13		5.12	7.50	440	24.35	6.40	185.7
1840	20.21		19.86		9.10		2.43	7.54	438	24.15	6.42	186.7
1900	20.18	*1165035.4	19.86	*7538.89	9.10		1.74	7.53	436	23.91	6.416	188.7
1920	20.21		19.92		9.03		6.57	7.52	434	23.78	6.43	190.0
1940	20.12		19.80		9.03		7.35	7.52	436	23.95	5.91	190.7
2000	20.12	*1166282.6	19.80	*8767.02	9.03		3.08	7.52	435	23.79	5.70	191.5
2020	20.20		19.97		9.01		3.68	7.53	434	23.80	5.34	191.9
2040	20.18		19.86		9.02		3.38	7.54	435	23.81	5.36	192.3
2100	20.14	*1167452.2	19.92	*9917.43	8.97		3.39	7.53	434	23.70	5.50	192.7
2120	20.26		19.92		8.96		3.13	7.54	438	23.82	5.77	192.8
2140	20.12		19.80		8.99		4.32	7.55	436	23.72	5.82	193.0
2200	20.21	*1168691.5	19.80	*11143.5	8.94		1.60	7.55	437	23.81	5.90	192.0
2220	20.10		19.74		8.97		8.71	7.55	437	23.78	6.03	191.2
2240	20.08		19.80		8.97		3.00	7.55	437	23.75	5.96	191.2
2300	20.17	*1169893.0	19.92	*12323.1	9.00		5.30	7.54	434	23.21	6.05	192.8
2320	20.07		19.92		8.99		4.86	7.54	429	23.51	5.91	193.1
2340	20.23		19.92		8.96		2.53	7.55	436	23.84	6.28	192.7
2400	20.07	*1171094.2	19.80	*13502.7	8.93		1.20	7.55	438	23.81	6.16	190.8
	5-12-15				3					23.71	6.11	190.9
0020	20.22		19.92		8.93		1.37	7.54	438	23.07	5.87	192.3
0040	20.25		19.97		8.94		1.59	7.54	436	22.96	5.87	192.3
0100	20.23	*1172314	19.92	*14708.7	8.95		4.02	7.55	429	22.86	5.51	191.8
0120	20.29		20.02		8.94		2.16	7.53	439	23.78	6.84	192.3

PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: J. SIMENEZ (NATIONAL) K. FORD (H.A)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments	
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)								
0140	20.23		19.97		8.96		1.13	7.55	438	23.83	DO mg/L	ORP
0200	*19.96	*1173528.3	19.74	15905.7	8.96		1.31	7.54	439	23.92	6.64	191.9
0220	20.00		19.68		8.96		.92	7.54	440	23.92	6.82	191.1
0240	19.89		19.56		8.96		1.25	7.54	441	24.01	6.61	191.2
0300	*19.92	*1174720.8	19.62	17082.6	8.92		1.02	7.55	441	24.02	6.68	190.1
0320	19.94		19.62		8.92		1.23	7.54	440	23.96	6.67	189.0
0340	20.07		19.86		8.89		1.34	7.55	439	23.91	6.79	187.9
0400	19.57	*1175945.2	19.34	18292.6	8.89		1.06	7.55	440	23.94	6.72	187.4
0420	20.07		19.80		8.89		1.05	7.54	430	23.23	6.44	189.3
0440	19.99		19.74		8.85		1.00	7.52	437	23.78	7.50	189.6
0500	20.11	*1177142.8	19.86	19472.0	8.87		1.76	7.54	439	23.76	7.33	188.8
0520	20.01		19.79		8.85		1.70	7.54	438	23.82	7.29	189.0
0540	20.22		19.97		8.86		2.58	7.54	441	23.93	7.22	187.5
0600	20.22	*1178338.1	20.19	20646.4	8.88		2.26	7.53	450	23.44	7.08	187.1
0620	20.26		19.97		8.86		0.84	7.53	451	23.14	7.33	188.0
0640	20.21		19.92		8.88		1.21	7.53	451	22.07	7.67	188.7
0700	20.28	*1179553.1	20.02	21847.2	8.86		0.92	7.53	452	22.98	6.69	188.3
0720	20.19		19.86		8.86		0.82	7.52	449	23.58	6.54	186.0
0740	20.28		19.97		8.82		1.34	7.53	451	23.93	6.35	184.6
0800	20.16	*1180767.2	19.74	23037.5	8.84		0.99	7.53	451	24.10	6.47	184.0
0820	20.25		19.86		8.83		0.89	7.52	451	24.10	7.05	183.7
0840	20.14		19.86		8.80		0.83	7.52	451	23.98	6.93	182.5
0900	20.24	*1181978.2	19.86	24226.0	8.84		0.86	7.53	452	23.96	6.83	182.0
0920	20.06		19.74		8.80		0.76	7.53	451	24.07	6.82	181.8
0940	19.87		19.57		8.78		1.02	7.53	451	24.19	7.31	181.4
1000	20.23	*1183188.4	19.92	25415.4	8.79		1.37	7.52	451	24.19	6.71	180.3
1020	20.19		19.86		8.79		1.25	7.53	452	24.20	6.00	179.6
1040	20.21		19.80		8.77		0.88	7.52	452	24.11	6.26	179.4
1100	20.17	*1184403.3	19.80	26610.4	8.83		0.86	7.53	452	24.07	5.94	179.1
1120	20.28		19.97		8.82		2.59	7.53	452	24.00	5.88	179.1

PUMPING TEST  
FIELD DATA LOG

Well No.: <u>NSH-006</u>	Static water level (ft, bmp): <u>655.41 (5/8/15)</u>	Static Feet of Water on Probe: <u>13.40</u>
Personnel & Company: <u>KFORD (H.A.), J. JIMENEZ (NAT'L)</u>		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments	
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)							DO (mg/L)	ORP
11-12-15												
1140	20.26		19.92		8.84		1.31	7.53	452	24.05	5.80	179.2
1200	20.21	*1185617.5	19.80	27804.7	8.78		0.78	7.53	453	24.10	5.94	178.9
1220	20.28		19.92		8.80		0.86	7.53	452	24.06	5.69	179.1
1240	20.22		19.92		8.76		0.87	7.53	452	24.07	5.85	178.5
1300	20.17	*1186832.6	19.86	28999.0	8.81		0.86	7.52	454	24.05	6.29	178.5
1320	20.24		19.92		8.81		0.94	7.53	452	24.01	6.01	178.1
1340	20.26		19.92		8.78		1.30	7.52	453	24.05	6.19	177.7
1400	20.35	*1188048.3	19.97	30194.7	8.78		1.05	7.52	453	24.04	5.70	177.0
1420	19.90		19.51		8.77		1.42	7.51	453	24.16	7.24	177.1
1440	20.24		19.86		8.77		0.84	7.52	454	24.15	6.90	176.8
1500	20.25	*1189262.5	19.86	31388.2	8.81		1.35	7.52	454	24.14	6.35	176.2
1520	20.23		19.86		8.81		1.05	7.52	454	24.07	6.64	176.2
1540	20.26		19.97		8.79		1.45	7.52	454	24.09	5.51	175.8
1600	20.35	*1190478.4	20.02	32584.6	8.79		1.03	7.53	453	24.04	6.53	175.7
1620	20.13		19.74		8.80		0.95	7.54	454	24.00	6.32	175.4
1640	20.22		19.92		8.82		0.68	7.54	453	23.56	6.16	176.2
1700	20.19	*1191692.3	19.92	33780.4	8.78		0.90	7.53	453	23.81	5.92	176.7
1720	20.15		19.86		8.80		0.73	7.53	452	22.95	5.97	177.4
1740	20.24		19.97		8.81		0.71	7.52	453	23.66	5.83	177.7
1800	19.80	1192914.5	19.46	34989.5	8.83		1.23	7.52	446	24.06	7.32	176.4
1820	19.64		19.34		8.82		1.65	7.53	446	24.02	6.88	175.0
1840	20.06		19.74		8.85		7.38	7.52	441	23.59	6.64	175.2
1900	19.96	*1194156.7	19.68	36211.2	8.80		2.45	7.52	446	23.98	6.73	175.8
1920	20.03		19.80		8.81		1.91	7.54	444	23.85	6.67	175.3
1940	20.12		19.86		8.79		2.31	7.54	442	23.75	6.17	175.6
2000	20.08	*1195352.9	19.75	37393.3	8.79		4.11	7.52	439	23.60	6.75	176.0
2020	20.11		19.86		8.79		5.85	7.53	436	23.22	6.75	176.4
2040	19.99		19.68		8.79		2.17	7.52	444	23.79	6.72	176.7
2100	19.99	*1196542.8	19.80	38565.7	8.80		1.46	7.53	435	23.33	6.70	177.1

PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: J. SIMENEZ (NATIONAL), K. FORD (H-A)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments	
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)							DO $\frac{mg}{L}$	ORP
2120	19.94		19.68		8.72		1.67	7.52	443	23.79	7.28	176.8
2140	19.83		19.51		8.72		.73	7.52	446	24.00	7.40	175.7
2200	19.86	* 1197740.6	19.56	39747.5	8.81		2.77	7.52	446	24.01	7.47	175.2
2220	19.95		19.68		8.79		1.12	7.52	443	23.71	6.94	174.8
2240	19.66		19.34		8.72		3.08	7.52	446	24.02	7.73	175.2
2300	19.92	* 1198966.1	19.57	40955.4	8.72		.85	7.52	447	24.04	7.58	173.9
2320	20.05		19.68		8.73		.66	7.53	444	23.84	7.53	173.7
2340	20.06		19.80		8.74		1.76	7.53	444	23.72	7.53	173.5
2400	20.01	* 1200162.3	19.74	42133.4	8.72		2.82	7.52	441	23.64	7.18	174.2
0020	20.02		19.68		8.72		1.20	7.53	445	23.85	7.15	173.6
0040	19.98		19.68		8.73		3.37	7.52	446	23.97	7.19	173.7
0100	20.03	* 1201374.2	19.80	43325.0	8.73		4.61	7.50	440	23.28	7.13	175.3
0120	19.98		19.74		8.77		2.11	7.53	442	23.56	7.13	174.0
0140	19.90		19.57		8.70		3.85	7.51	448	24.02	7.39	173.8
0200	20.13	* 1202596.6	19.92	44529.5	8.73		1.49	7.53	437	23.67	6.78	174.0
0220	20.19		19.97		8.72		2.02	7.52	439	23.48	6.72	174.7
0240	20.06		19.80		8.77		1.38	7.52	443	23.72	6.81	174.8
0300	20.14	* 1203820.6	19.86	45739.2	8.75		1.45	7.54	443	23.67	6.80	173.9
0320	20.04		19.74		8.69		1.64	7.51	443	23.59	7.46	175.2
0340	19.82		19.56		8.76		1.70	7.52	441	23.23	6.51	173.7
0400	20.23	* 1205039.9	20.02	46941.0	8.75		1.28	7.54	444	23.62	7.10	172.4
0420	19.69		19.29		8.72		1.38	7.51	449	24.05	8.07	172.7
0440	19.99		19.74		8.68		1.60	7.53	447	23.95	7.28	171.1
0500	20.12	* 1206222.3	19.97	48107.3	8.74		1.04	7.53	447	23.90	6.92	170.9
0520	19.98		19.68		8.72		.98	7.52	448	24.00	7.35	171.0
0540	19.98		19.62		8.70		1.16	7.53	448	23.90	6.98	170.4
0600	20.16	* 1207397.3	19.97	49261.1	8.71		0.83	7.52	457	24.04	6.96	169.7
0620	20.26		19.97		8.71		0.76	7.52	458	23.98	6.92	169.0
0640	20.28		19.97		8.71		0.86	7.52	457	24.02	6.91	168.2
0700	20.25	* 1208612.6	19.92	50460.8	8.72		1.08	7.53	457	24.03	6.89	167.6



PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41 (5/8/15)	Static Feet of Water on Probe: 13.40
Personnel & Company: KFOED (H-A)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	Comments	
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)							DO (mg/L)	ORP
5-13-15												
0720	20.27		19.97		8.67		0.84	7.52	457	23.99	6.26	167.2
0740	20.32		20.02		8.70		0.73	7.52	457	24.06	6.51	167.8
0800	20.22	1209829.6	19.92	51659.3	8.75		0.98	7.52	457	24.12	6.31	167.6
0820	20.22		19.92		8.68		0.77	7.52	456	24.04	6.87	167.6
0840	20.32		19.97		8.75		1.51	7.52	458	23.94	6.27	167.5
0900	20.36	1211048.1	20.02	52860.6	8.71		1.11	7.52	458	24.07	6.52	167.2
0905	CALIBRATE YSI											
0920	20.30		19.97		8.73		1.08	7.13	525	23.83	7.19	133.3
0940	20.29		19.97		8.74		0.84	7.36	514	23.91	6.47	139.5
1000	20.31	1212268.9	19.97	54060.7	8.72		0.75	7.38	514	24.06	6.38	148.4
1020	20.25		19.92		8.73		0.76	7.39	514	24.03	5.88	153.7
1040	20.25		19.92		8.80		0.66	7.38	513	23.99	6.74	156.8
1100	20.24	1213489.3	19.92	55267.6	8.75		0.77	7.39	513	24.30	6.01	158.7
1120	20.23		19.92		8.79		0.69	7.39	514	24.56	6.29	158.3
1140	20.26		19.92		8.83		0.60	7.39	514	24.82	6.65	157.9
1200	20.19	1214712.3	19.86	56460.5	8.82		0.86	7.39	514	24.69	5.76	158.1
1220	20.24		19.92		8.79		1.06	7.40	514	25.36	6.68	155.9
1230	20.19		19.80		8.84		0.90	7.39	514	24.94	6.43	156.2
1240	20.21		19.80		8.84		0.58	7.40	514	24.95	6.52	156.2
1250	20.19		19.80		8.86		1.29	7.40	513	24.44	6.73	156.8
1300	20.13	1215912.2	19.80	57638.3	8.84		0.79	7.38	513	24.75	6.60	157.1
1310	20.22		19.80		-		0.81	7.39	513	24.87	5.83	156.7
1320	20.14		19.80		-		0.53	7.39	514	24.67	5.92	156.5
1330	20.10		19.62		-		0.98	7.39	514	24.91	5.75	156.5
1340	20.21		19.86		-		0.79	7.39	514	24.86	5.59	156.2
1350	20.23		19.86		-		0.57	7.41	514	25.14	6.25	155.5
1400	20.16	1217122.5	19.80	58826.3	8.89		0.80	7.39	514	24.90	5.87	155.6
~1405 - 1445	SAMPLING											
1450	20.11		19.74		8.89		0.66	7.39	515	24.45	6.17	151.5

PUMPING TEST  
FIELD DATA LOG

Well No.: NSH-006	Static water level (ft, bmp): 655.41	Static Feet of Water on Probe: 13.40
Personnel & Company: KFOROS (H+A)		

Time & Date	McCrometer		GPI		Transducer Reading (feet water)	Sand Content ml/l	Turbidity (NTU)	pH	Sp. Cond. (µS/cm)	Temp. °C	DO (mg/L)	Comments	ORP
	Discharge Rate (gpm)	Totalizer (gals)	Discharge Rate (gpm)	Totalizer (gals)									
5-13-15													
1500	20.17	1218331.2	19.80	60013.4	8.94		1.02	7.39	515	24.90	5.58		152.0
1510	20.20		19.86		8.93		0.94	7.40	514	24.88	5.79		152.2
1520	20.11		19.80		8.91		0.69	7.39	516	24.61	6.46		153.3
CALIBRATE	4.51												
1540	20.01		19.68		8.93		1.36	7.20	510	24.70	6.61		133.7
1600	20.27	1219540.5	19.92	61202.0	8.93		0.96	7.37	495	24.40	5.94		142.8
1620	20.06		19.68		8.94		0.83	7.39	493	24.38	6.58		151.7
1640	20.14		19.86		8.89		0.80	7.39	491	24.30	5.97		157.5
1700	20.07	1220747.6	19.80	62389.6	8.93		1.20	7.39	491	24.37	5.66		161.0
1720	20.18		19.92		8.92		1.07	7.39	491	24.13	6.03		162.9
1740	20.33		19.97		8.96		0.45	7.40	491	24.03	5.45		164.2
1800	20.17	1222000.7	19.92	63627.0	8.94		1.86	7.40	482	24.13	6.04		165.0
1820	19.99		19.74		8.92		3.28	7.40	482	24.01	7.11		165.1
1840	19.99		19.74		8.90		1.31	7.40	483	24.10	7.15		165.7
1900	20.00	1223175.0	19.62	64784.5	8.89		.91	7.40	483	24.07	7.17		166.3
1920	19.95		19.68		8.90		.88	7.40	482	24.06	7.44		166.5
1940	19.90		19.51		8.87		1.83	7.40	483	24.14	7.79		166.1
2000	20.10	1224381.3	19.80	65974.4	8.83		.61	7.41	483	24.06	7.12		165.9
2020	19.91		19.62		8.86		.84	7.41	483	24.06	7.11		166.1
2040	20.01		19.74		8.87		.66	7.40	482	24.02	7.03		166.2
2100	20.17	1225593.2	19.74	67170.0	8.85		.55	7.40	482	23.98	6.96		166.6
2120	20.34		20.08		8.82		.77	7.41	481	23.89	6.99		167.2
2140	20.27		20.08		8.85		.49	7.41	481	23.89	6.98		166.6
2200	20.21	*1226806.0	19.97	68366.6	8.88		.50	7.41	481	23.88	6.97		166.4
2220	20.19		19.97		8.89		.67	7.42	481	23.91	6.93		167.8
2240	20.19		19.92		8.90		.49	7.41	481	23.87	7.04		166.7
2300	20.16	1228020.8	19.86	69563.1	8.91		.51	7.41	481	23.90	7.10		166.1
2320	20.25		19.97		8.85		.42	7.41	481	23.90	6.55		166.6
2340	20.15		19.92		8.80		.76	7.41	482	24.04	7.64		166.3



**EXHIBIT 2**

**SULFURIC ACID SPECIFICATIONS**





25775 Oak Ridge Dr., Suite 140  
The Woodlands, TX  
77380

#### SPECIFICATIONS

#### LIMITS

Property	Units	Min	Max
Acidity as H <sub>2</sub> SO <sub>4</sub>	%	93.0	98.5
Light Trans@ 425 nm	% LT	70	
Color, APHA	APHA Units		100
Nitrates (or NO <sub>x</sub> )	ppm w/w		100 (20)
SO <sub>2</sub>	ppm w/w		40
Iron as Total Fe	ppm w/w		50
Chlorides	ppm w/w		16
Antimony	ppm w/w		0.1
Arsenic	ppm w/w		4
Cadmium	ppm w/w		0.1
Chromium	ppm w/w		1
Lead	ppm w/w		1
Manganese	ppm w/w		1
Mercury	ppm w/w		1
Nickel	ppm w/w		2
Selenium	ppm w/w		0.1
Zinc	ppm w/w		1

#### OTHER INFORMATION

DOT Hazard Classification: Corrosive Liquid

#### PHYSICAL DESCRIPTION

Property	Typical Value	Units
Specific Gravity at 60 degrees F°	1.84	
Density at 60 degrees F°	15.4 (115.2)	lb/ gal (lb/cu.ft.)
Approx. Freezing Point	29 (-2)	deg F° (deg C° )
Approx Boiling Point	621 (327)	deg F° (deg C° )
Viscosity at 68 degrees F°	25	centipoise
Specific Heat	0.35	cal/g-deg C° (=btu/l)
Appearance	Clear & free	

### SULFURIC ACID SPECIFICATIONS

98% TECHNICAL GRADE		
ANALYSIS	MAXIMUM SPECIFICATION	TYPICAL RANGE
Strength (% H <sub>2</sub> SO <sub>4</sub> )	98.00 (min)	98.2 – 98.6
Color	Clear to slightly yellow	Clear, water white
Transmittance	75 (min)	90 – 95
Specific Gravity	1.8437	1.843 - 1.8435
Oxidizables (ml KMnO <sub>4</sub> )	5.0	1.0 – 3.0
<b>Trace Impurities</b>	<b>ppm</b>	<b>ppm</b>
Arsenic (As)	0.5	0.1 - 0.4
Antimony (Sb)	0.5	0.05 - 0.15
Chlorine (Cl)	5	< 1
Copper (Cu)	0.5	0.2 - 0.5
Iron (Fe)	50	7 – 15
Lead (Pb)	4.0	0.1 - 0.7
Manganese (Mn)	0.2	0.05 - 0.15
Nickel (Ni)	0.5	0.07 - 0.20
Nitrates (NO <sub>3</sub> )	5	< 5
Sulfurous Acid (SO <sub>2</sub> )	40	2 – 15
Zinc (Zn)	2.0	0.05 - 0.75
Heavy Metals (as Bi, Cd, Pb)	10	< 1
Fixed Residue	250	70 - 175

**Note:** Asarco sulfuric acid complies with Food Chemicals Codex V standards



Certified to ANSI Standard 60

Rev. 15-Jun-2011

### SULFURIC ACID SPECIFICATIONS

93% TECHNICAL GRADE		
ANALYSIS	MAXIMUM SPECIFICATION	TYPICAL RANGE
Strength (% H <sub>2</sub> SO <sub>4</sub> )	93.0 (min)	93.5 ± 0.4
Color	Clear to slightly yellow	Clear, water white
Transmittance (Clarity/Turbidity)	86 (min)	95 – 100
Specific Gravity	1.834	1.836 – 1.8385
Oxidizables (ml KMnO <sub>4</sub> )	5.0	1.0 – 3.0
<b>Trace Impurities</b>	<b>ppm</b>	<b>ppm</b>
Arsenic (As)	0.5	0.1 – 0.4
Antimony (Sb)	0.5	0.05 – 0.15
Chlorine (Cl)	5	< 1
Copper (Cu)	0.5	0.2 – 0.5
Iron (Fe)	50	7 – 20
Lead (Pb)	4.0	0.1 – 0.7
Manganese (Mn)	0.2	0.05 – 0.15
Nickel (Ni)	0.5	0.07 – 0.20
Nitrates (NO <sub>3</sub> )	5	< 5
Sulfurous Acid (SO <sub>2</sub> )	100	30 – 60
Zinc (Zn)	2.0	0.05 – 0.75
Heavy Metals (as Bi, Cd, Pb)	10	< 1
Fixed Residue	250	70 - 175

**Note:** Asarco sulfuric acid complies with Food Chemicals Codex V standards



Certified to ANSI Standard 60

Rev. 15-Jun-2011

**EXHIBIT 3**

**JOHNSON CAMP RAFFINATE LABORATORY REPORTS**



**SGS North America Inc.**

7701 N. Business Park Dr.

Tucson, AZ 85743

phone: 520.579.8315

fax: 520.579.7045

www.sgs.com

**Analysis Report  
Excelsior Mining Corp.**

Project Number: M959-01A

Number of Samples: 1

Print Date: 01.26.15

Service Codes: A0002E30, A0001Be, A0001Se

Assay No.	Description	ICP Analysis														
		Ag	Al	As	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	La	Mg
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
78920	JC raff 012215	<1	7887	<1	<1	<1	470	4	19	1	8	135	<1	108	<1	6184
	Duplicate	<1	7885	<1	<1	<1	472	4	19	1	8	136	<1	108	<1	6181
	Method	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP
	Minimum Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Assay No.	Description	ICP Analysis														
		Mn	Mo	Na	Ni	P	Pb	Sb	Sc	Sr	Ti	Tl	V	W	Zn	Zr
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
78920	JC raff 012215	1092	<1	110	16	76	<1	<1	<1	<1	<1	4	<1	12	815	<1
	Duplicate	1092	<1	110	16	76	<1	<1	<1	<1	<1	4	<1	12	815	<1
	Method	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP
	Minimum Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Assay No.	Description	Analysis	
		Be	Se
		ppm	ppm
78920	JC raff 012215	4	<1
	Duplicate	4	<1
	Method	ICP	ICP
	Minimum Detection	1	1

Signature: \_\_\_\_\_

7701 N. Business Park Dr.

Tucson, AZ 85743

phone: 520.579.8315

fax: 520.579.7045

[www.metconresearch.com](http://www.metconresearch.com)

## Certificate of Analysis

### Excelsior Mining

Metcon Project Number: M817-01

Number of Samples: 1

Print Date: 8.21.12

Service Codes: A0002E30, A0001Su

Assay No.	Description		ICP Analysis	SO4=
			S	
			g/l	
58931	29485	Raff Solution	28.25	84.75
		Duplicate	28.75	86.25
		Method	ICP	
		Minimum Detection	0.01	

Signature: \_\_\_\_\_



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ALS Environmental  
ALS Group USA, Corp  
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F : +1 360 636 1068  
[www.alsglobal.com](http://www.alsglobal.com)

August 05, 2015

**Analytical Report for Service Request No: K1507398**  
**Revised Service Request No: K1507398.01**

Kate Duke  
Duke Hydro Chem  
P.O. Box 41716  
Tucson, AZ 85717

**RE: Gunnison**

Dear Kate,

Enclosed is the revised report for the sample(s) submitted to our laboratory July 09, 2015  
For your reference, these analyses have been assigned our service request number **K1507398**.

The Case Narrative for the metals analysis was revised.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at [www.alsglobal.com](http://www.alsglobal.com). All results are intended to be considered in their entirety, and ALS Group USA Corp. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 3364. You may also contact me via email at [howard.holmes@alsglobal.com](mailto:howard.holmes@alsglobal.com).

Respectfully submitted,

**ALS Group USA, Corp. dba ALS Environmental**

Howard Holmes  
Project Manager



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1317 South 13th Avenue  
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## Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

### **Inorganic Data Qualifiers**

- \* The result is an outlier. See case narrative.
- # The control limit criteria is not applicable. See case narrative.
- B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
- E The result is an estimate amount because the value exceeded the instrument calibration range.
- J The result is an estimated value.
- U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.  
*DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
- i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
- X See case narrative.
- Q See case narrative. One or more quality control criteria was outside the limits.
- H The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

### **Metals Data Qualifiers**

- # The control limit criteria is not applicable. See case narrative.
- J The result is an estimated value.
- E The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
- M The duplicate injection precision was not met.
- N The Matrix Spike sample recovery is not within control limits. See case narrative.
- S The reported value was determined by the Method of Standard Additions (MSA).
- U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.  
*DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
- W The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
- i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
- X See case narrative.
- + The correlation coefficient for the MSA is less than 0.995.
- Q See case narrative. One or more quality control criteria was outside the limits.

### **Organic Data Qualifiers**

- \* The result is an outlier. See case narrative.
- # The control limit criteria is not applicable. See case narrative.
- A A tentatively identified compound, a suspected aldol-condensation product.
- B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
- C The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
- D The reported result is from a dilution.
- E The result is an estimated value.
- J The result is an estimated value.
- N The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
- P The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
- U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.  
*DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
- i The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
- X See case narrative.
- Q See case narrative. One or more quality control criteria was outside the limits.

### **Additional Petroleum Hydrocarbon Specific Qualifiers**

- F The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
- L The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
- H The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
- O The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
- Y The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
- Z The chromatographic fingerprint does not resemble a petroleum product.

**ALS Group USA Corp. dba ALS Environmental (ALS) - Kelso**  
**State Certifications, Accreditations, and Licenses**

<b>Agency</b>	<b>Web Site</b>	<b>Number</b>
Alaska DEC UST	<a href="http://dec.alaska.gov/applications/eh/ehllabreports/USTLabs.aspx">http://dec.alaska.gov/applications/eh/ehllabreports/USTLabs.aspx</a>	UST-040
Arizona DHS	<a href="http://www.azdhs.gov/lab/license/env.htm">http://www.azdhs.gov/lab/license/env.htm</a>	AZ0339
Arkansas - DEQ	<a href="http://www.adeq.state.ar.us/techsvs/labcert.htm">http://www.adeq.state.ar.us/techsvs/labcert.htm</a>	88-0637
California DHS (ELAP)	<a href="http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx">http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx</a>	2795
DOD ELAP	<a href="http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm">http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm</a>	L14-51
Florida DOH	<a href="http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm">http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm</a>	E87412
Hawaii DOH	Not available	-
Idaho DHW	<a href="http://www.healthandwelfare.idaho.gov/Health/Labs/CertificationDrinkingWaterLabs/tabid/1833/Default.aspx">http://www.healthandwelfare.idaho.gov/Health/Labs/CertificationDrinkingWaterLabs/tabid/1833/Default.aspx</a>	-
ISO 17025	<a href="http://www.pjllabs.com/">http://www.pjllabs.com/</a>	L14-50
Louisiana DEQ	<a href="http://www.deq.louisiana.gov/portal/DIVISIONS/PublicParticipationandPermitSupport/LouisianaLaboratoryAccreditationProgram.aspx">http://www.deq.louisiana.gov/portal/DIVISIONS/PublicParticipationandPermitSupport/LouisianaLaboratoryAccreditationProgram.aspx</a>	03016
Maine DHS	Not available	WA01276
Michigan DEQ	<a href="http://www.michigan.gov/deq/0,1607,7-135-3307_4131_4156---,00.html">http://www.michigan.gov/deq/0,1607,7-135-3307_4131_4156---,00.html</a>	9949
Minnesota DOH	<a href="http://www.health.state.mn.us/accreditation">http://www.health.state.mn.us/accreditation</a>	053-999-457
Montana DPHHS	<a href="http://www.dphhs.mt.gov/publichealth/">http://www.dphhs.mt.gov/publichealth/</a>	CERT0047
Nevada DEP	<a href="http://ndep.nv.gov/bsdwlabservice.htm">http://ndep.nv.gov/bsdwlabservice.htm</a>	WA01276
New Jersey DEP	<a href="http://www.nj.gov/dep/oqa/">http://www.nj.gov/dep/oqa/</a>	WA005
North Carolina DWQ	<a href="http://www.dwqlab.org/">http://www.dwqlab.org/</a>	605
Oklahoma DEQ	<a href="http://www.deq.state.ok.us/CSDnew/labcert.htm">http://www.deq.state.ok.us/CSDnew/labcert.htm</a>	9801
Oregon – DEQ (NELAP)	<a href="http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx">http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx</a>	WA100010
South Carolina DHEC	<a href="http://www.scdhec.gov/environment/envserv/">http://www.scdhec.gov/environment/envserv/</a>	61002
Texas CEQ	<a href="http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html">http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html</a>	T104704427
Washington DOE	<a href="http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html">http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html</a>	C544
Wisconsin DNR	<a href="http://dnr.wi.gov/">http://dnr.wi.gov/</a>	998386840
Wyoming (EPA Region 8)	<a href="http://www.epa.gov/region8/water/dwhome/wyomingdi.html">http://www.epa.gov/region8/water/dwhome/wyomingdi.html</a>	-
Kelso Laboratory Website	<a href="http://www.alsglobal.com">www.alsglobal.com</a>	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at [www.ALSGlobal.com](http://www.ALSGlobal.com) or at the accreditation bodies web site.

Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/analyte is offered by that state.



## Case Narrative

**ALS Environmental—Kelso Laboratory**  
1317 South 13th Avenue, Kelso, WA 98626  
Phone (360)577-7222 Fax (360)636-1068  
[www.alsglobal.com](http://www.alsglobal.com)

## ALS ENVIRONMENTAL

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request No.:** K1507398  
**Date Received:** 07/09/15

### Case Narrative

All analyses were performed consistent with the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II data deliverables. When appropriate to the method, method blank results have been reported with each analytical test. Additional quality control analyses reported herein include: Laboratory Duplicate (DUP), Matrix Spike (MS), and Matrix/Duplicate Matrix Spike (MS/DMS).

### Sample Receipt

One water sample was received for analysis at ALS Environmental on 07/09/15. The sample was received in good condition and consistent with the accompanying chain of custody form, except where noted on the cooler receipt and preservation form included in this report. The sample was stored in a refrigerator at 4°C upon receipt at the laboratory.

### General Chemistry Parameters

#### **Fluoride by Standard Method 4500-F-C Modified:**

The matrix spike recoveries for sample JC Raff 3/6/2015 were outside control criteria because of suspected matrix interference. As a result of the interference, the results for this analyte contained a potential low bias. No further corrective action was taken.

The Relative Percent Difference (RPD) in the replicate matrix spike analyses of sample JC Raff 3/6/2015 was outside control criteria. Recovery in the Laboratory Control Sample (LCS) was within acceptance limits, indicating the analytical batch was in control. No further corrective action was appropriate.

#### **Fluoride by Standard Method 4500-F-C:**

The control criteria for matrix spike recoveries for sample JC Raff 3/6/2015 were not applicable. The analyte concentration in the sample was significantly higher than the added spike concentration, preventing accurate evaluation of the spike recovery.

No other anomalies associated with the analysis of this sample were observed.

### Total Metals

No anomalies associated with this analysis were observed.

Approved by \_\_\_\_\_





## Chain of Custody

**ALS Environmental—Kelso Laboratory**  
1317 South 13th Avenue, Kelso, WA 98626  
Phone (360)577-7222 Fax (360)636-1068  
[www.alsglobal.com](http://www.alsglobal.com)

# ALS Environmental-Kelso

1317 South 13th, Kelso, WA 98626

(360) 577-7222 FAX (360) 636-1068

SR# K1507398  
PAGE 1 OF 1

Project Name: GUNNISON Project Number:         
Project Manager: KATE DUKE Company: DUKE HYDROCHEM  
Company/Address: PO Box 41716 Phone: 520-419-9268  
City, State, Zip: TUCSON AZ 85717 FAX:         
Sampler's Signature: Kate Duke

Sample I.D.	Date	Time	LAB ID	Matrix	Number of Containers	EPA 200.8 Sb, Ba, Ag, Pb	EPA 7062 As	EPA 245.1 Hg	EPA 7742 Se	SM 4500 Cl-C Cl	SM 4500 F-C F	REMARKS
JC Raff 316/2015	7/7/15	1530		H <sub>2</sub> O	1	-	-	-	-	-	-	

**TURNAROUND REQUIREMENTS**  
 \_\_\_ 24 hr \_\_\_ 48 hr X 5 day  
 \_\_\_ Standard (21 days)  
 \_\_\_ Provide FAX Preliminary Results  
 Requested Report Date:                     

**Invoice Information**  
 P.O. # CHARGE C/L  
 Bill to:                     

**REPORT REQUIREMENTS**  
X I. Routine Report: Results, Method Blank, Surrogate, as required  
 \_\_\_ II. Report Dup., MS, MSD as required  
 \_\_\_ III. Data Validation Report (includes raw data)  
 \_\_\_ IV. CLP Deliverable Report  
 \_\_\_ V. EDD

**Comments/Special Instructions:**  
ATTN: JEFF CORONADO

**RELINQUISHED BY:**  
 Signature: Kate Duke  
 Printed Name: KATE DUKE  
 Firm: DUKE HYDROCHEM  
 Date/Time: 7 JUL 2015 11636

**RECEIVED BY:**  
 Signature: [Signature]  
 Printed Name: SWOLF  
 Firm: A25  
 Date/Time: 7/9/15 1000

**RELINQUISHED BY:**  
 Signature:                       
 Printed Name:                       
 Firm:                       
 Date/Time:                     

**RECEIVED BY:**  
 Signature:                       
 Printed Name:                       
 Firm:                       
 Date/Time:

PC H2

## Cooler Receipt and Preservation Form

Client / Project:

Duke Hydro ChemService Request K1507398Received: 7/9/15Opened: 7/9/15By: [Signature]Unloaded: 7/9/15By: [Signature]

1. Samples were received via? Mail Fed Ex UPS DHL PDX Courier Hand Delivered
2. Samples were received in: (circle) Cooler Box Envelope Other NA
3. Were custody seals on coolers? NA Y N If yes, how many and where? \_\_\_\_\_
- If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID	Tracking Number	NA	Filed
<u>MM</u>							<u>4740 0065 1190</u>		

4. Packing material: Inserts Baggies Bubble Wrap Gel Packs Wet Ice Dry Ice Sleeves \_\_\_\_\_
5. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
6. Did all bottles arrive in good condition (unbroken)? Indicate in the table below. NA Y N
7. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
8. Did all sample labels and tags agree with custody papers? Indicate major discrepancies in the table on page 2. NA Y N
9. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
10. Were the pH-preserved bottles (see SMO GEN SOP) received at the appropriate pH? Indicate in the table below NA Y N
11. Were VOA vials received without headspace? Indicate in the table below. NA Y N
12. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count	Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time
<u>Sample aliquoted for</u>	<u>500ml</u>	<u>250ml</u>				<u>X</u>	<u>HNO<sub>3</sub></u>	<u>1ml</u>	<u>RE/1-31-L</u>	<u>[Signature]</u>	<u>1120</u>
						<u>X</u>	<u>H<sub>2</sub>SO<sub>4</sub></u>	<u>0.5ml</u>	<u>Gen P/1-67-N</u>	<u>u</u>	<u>u</u>

**RUSH**

Notes, Discrepancies, &amp; Resolutions: \_\_\_\_\_





## General Chemistry

**ALS Environmental—Kelso Laboratory**  
1317 South 13th Avenue, Kelso, WA 98626  
Phone (360)577-7222 Fax (360)636-1068  
[www.alsglobal.com](http://www.alsglobal.com)

ALS Group USA, Corp.  
dba ALS Environmental

Analytical Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water  
**Analysis Method:** 353.2  
**Prep Method:** Method

**Service Request:** K1507398  
**Date Collected:** 07/7/15  
**Date Received:** 07/9/15  
**Units:** mg/L  
**Basis:** NA

Nitrate+Nitrite as Nitrogen

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
JC Raff 3/6/2015	K1507398-001	4.61	0.25	5	07/13/15 14:06	7/13/15	
Method Blank	K1507398-MB1	ND U	0.050	1	07/13/15 14:06	7/13/15	

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project** Gunnison  
**Sample Matrix:** Water  
  
**Analysis Method:** 353.2  
**Prep Method:** Method

**Service Request:**K1507398  
**Date Collected:**NA  
**Date Received:**NA  
  
**Units:**mg/L  
**Basis:**NA

**Replicate Sample Summary**  
**Nitrate+Nitrite as Nitrogen**

<b>Sample Name:</b>	<b>Lab Code:</b>	<b>MRL</b>	<b>Sample Result</b>	<b>Duplicate Result</b>	<b>Average</b>	<b>RPD</b>	<b>RPD Limit</b>	<b>Date Analyzed</b>
Batch QC	K1507210-004DUP	0.050	ND U	ND U	NC	NC	20	07/13/15
Batch QC	K1507231-001DUP	0.050	ND U	ND U	NC	NC	20	07/13/15

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Collected:** N/A  
**Date Received:** N/A  
**Date Analyzed:** 07/13/15  
**Date Extracted:** 07/13/15

**Duplicate Matrix Spike Summary**  
**Nitrate+Nitrite as Nitrogen**

**Sample Name:** Batch QC  
**Lab Code:** K1507210-004  
**Analysis Method:** 353.2  
**Prep Method:** Method

**Units:** mg/L  
**Basis:** NA

Analyte Name	Sample Result	Matrix Spike K1507210-004MS			Duplicate Matrix Spike K1507210-004DMS			% Rec Limits	RPD	RPD Limit
		Result	Spike Amount	% Rec	Result	Spike Amount	% Rec			
Nitrate+Nitrite as Nitrogen	ND U	1.11	1.00	111	1.12	1.00	112	89-114	<1	20

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Collected:** N/A  
**Date Received:** N/A  
**Date Analyzed:** 07/13/15  
**Date Extracted:** 07/13/15

**Duplicate Matrix Spike Summary**  
**Nitrate+Nitrite as Nitrogen**

**Sample Name:** Batch QC  
**Lab Code:** K1507231-001  
**Analysis Method:** 353.2  
**Prep Method:** Method

**Units:** mg/L  
**Basis:** NA

Analyte Name	Sample Result	Matrix Spike K1507231-001MS			Duplicate Matrix Spike K1507231-001DMS			% Rec Limits	RPD	RPD Limit
		Result	Spike Amount	% Rec	Result	Spike Amount	% Rec			
Nitrate+Nitrite as Nitrogen	ND U	1.00	1.00	100	1.03	1.00	103	89-114	3	20

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Analyzed:** 07/13/15  
**Date Extracted:** 07/13/15

**Lab Control Sample Summary**  
**Nitrate+Nitrite as Nitrogen**

**Analysis Method:** 353.2  
**Prep Method:** Method

**Units:** mg/L  
**Basis:** NA  
**Analysis Lot:** 452893

<b>Sample Name</b>	<b>Lab Code</b>	<b>Result</b>	<b>Spike Amount</b>	<b>% Rec</b>	<b>% Rec Limits</b>
Lab Control Sample	K1507398-LCS1	8.00	8.00	100	90-110

ALS Group USA, Corp.  
dba ALS Environmental

Analytical Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water  
**Analysis Method:** SM 4500-Cl- C  
**Prep Method:** None

**Service Request:** K1507398  
**Date Collected:** 07/7/15  
**Date Received:** 07/9/15  
**Units:** mg/L  
**Basis:** NA

Chloride

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Q
JC Raff 3/6/2015	K1507398-001	32.0	5.0	10	07/14/15 15:50	
Method Blank	K1507398-MB1	ND U	0.50	1	07/14/15 15:50	

**ALS Group USA, Corp.**

dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398**Date Collected:** 07/07/15**Date Received:** 07/09/15**Date Analyzed:** 07/14/15

**Replicate Sample Summary**  
**General Chemistry Parameters**

**Sample Name:** JC Raff 3/6/2015  
**Lab Code:** K1507398-001

**Units:** mg/L**Basis:** NA

				<b>Duplicate Sample K1507398- 001DUP1</b>			
<b>Analyte Name</b>	<b>Analysis Method</b>	<b>MRL</b>	<b>Sample Result</b>	<b>Result</b>	<b>Average</b>	<b>RPD</b>	<b>RPD Limit</b>
Chloride	SM 4500-Cl- C	5.0	32.0	31.0	31.5	3	20

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.



**ALS Group USA, Corp.**

dba ALS Environmental

## QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Collected:** 07/07/15  
**Date Received:** 07/09/15  
**Date Analyzed:** 07/14/15  
**Date Extracted:** NA

**Matrix Spike Summary  
Chloride**

**Sample Name:** JC Raff 3/6/2015  
**Lab Code:** K1507398-001  
**Analysis Method:** SM 4500-Cl- C  
**Prep Method:** None

**Units:** mg/L  
**Basis:** NA

**Matrix Spike  
K1507398-001MS1**

<b>Analyte Name</b>	<b>Sample Result</b>	<b>Result</b>	<b>Spike Amount</b>	<b>% Rec</b>	<b>% Rec Limits</b>
Chloride	32.0	236	200	102	75-125

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Analyzed:** 07/14/15  
**Date Extracted:** NA

**Lab Control Sample Summary**  
**Chloride**

**Analysis Method:** SM 4500-Cl- C  
**Prep Method:** None

**Units:** mg/L  
**Basis:** NA  
**Analysis Lot:** 453093

<b>Sample Name</b>	<b>Lab Code</b>	<b>Result</b>	<b>Spike Amount</b>	<b>% Rec</b>	<b>% Rec Limits</b>
Lab Control Sample	K1507398-LCS1	57.0	56.4	101	85-115

ALS Group USA, Corp.  
dba ALS Environmental

Analytical Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water  
**Analysis Method:** SM 4500-F- C  
**Prep Method:** SM 4500-F-B

**Service Request:** K1507398  
**Date Collected:** 07/7/15  
**Date Received:** 07/9/15  
**Units:** mg/L  
**Basis:** NA

Fluoride

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
JC Raff 3/6/2015	K1507398-001	873	89	100	07/21/15 10:25	7/21/15	
Method Blank	K1507398-MB1	ND U	0.94	1	07/21/15 10:25	7/21/15	

**ALS Group USA, Corp.**

dba ALS Environmental

## QA/QC Report

**Client:** Duke Hydro Chem  
**Project** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398**Date Collected:** 07/07/15**Date Received:** 07/09/15**Date Analyzed:** 07/21/15

**Replicate Sample Summary**  
**General Chemistry Parameters**

**Sample Name:** JC Raff 3/6/2015  
**Lab Code:** K1507398-001

**Units:** mg/L**Basis:** NA

				<b>Duplicate Sample K1507398- 001DUP1</b>			
<b>Analyte Name</b>	<b>Analysis Method</b>	<b>MRL</b>	<b>Sample Result</b>	<b>Result</b>	<b>Average</b>	<b>RPD</b>	<b>RPD Limit</b>
Fluoride	SM 4500-F- C	86	873	774	824	12	20

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Collected:** 07/07/15  
**Date Received:** 07/09/15  
**Date Analyzed:** 07/21/15  
**Date Extracted:** 07/21/15

**Duplicate Matrix Spike Summary**  
**Fluoride**

**Sample Name:** JC Raff 3/6/2015  
**Lab Code:** K1507398-001  
**Analysis Method:** SM 4500-F- C  
**Prep Method:** SM 4500-F-B

**Units:** mg/L  
**Basis:** NA

Analyte Name	Sample Result	Result	Matrix Spike K1507398-001MS1		Result	Duplicate Matrix Spike K1507398-001DMS1		% Rec Limits	RPD	RPD Limit
			Spike Amount	% Rec		Spike Amount	% Rec			
Fluoride	873	722	100	-151 #	830	100	-43 #	56-130	NC	20

Results flagged with an asterisk (\*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client:** Duke Hydro Chem  
**Project:** Gunnison  
**Sample Matrix:** Water

**Service Request:** K1507398  
**Date Analyzed:** 07/21/15  
**Date Extracted:** 07/21/15

**Lab Control Sample Summary**  
**Fluoride**

**Analysis Method:** SM 4500-F- C  
**Prep Method:** SM 4500-F-B

**Units:** mg/L  
**Basis:** NA  
**Analysis Lot:** 453998

<b>Sample Name</b>	<b>Lab Code</b>	<b>Result</b>	<b>Spike Amount</b>	<b>% Rec</b>	<b>% Rec Limits</b>
Lab Control Sample	K1507398-LCS1	7.66	8.52	90	85-115



# Metals

**ALS Environmental—Kelso Laboratory**  
1317 South 13th Avenue, Kelso, WA 98626  
Phone (360)577-7222 Fax (360)636-1068  
[www.alsglobal.com](http://www.alsglobal.com)

ALS Group USA, Corp.  
dba ALS Environmental

Analytical Report

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** 07/07/15  
**Date Received :** 07/09/15  
**Date Extracted :** 07/10-15/15

Total Metals

**Sample Name :** JC Raff 3/6/2015  
**Lab Code :** K1507398-001

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Antimony	200.8	0.005	07/14/15	ND	
Arsenic	7062	0.005	07/14/15	ND	
Barium	200.8	0.005	07/14/15	0.046	
Lead	200.8	0.002	07/14/15	0.005	
Mercury	245.1	0.001	07/15/15	ND	
Selenium	7742	0.005	07/15/15	0.050	
Silver	200.8	0.002	07/14/15	0.155	

Comments:



ALS Group USA, Corp.  
dba ALS Enviromental

Analytical Report

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** NA  
**Date Received :** NA  
**Date Extracted :** 07/10-15/15

Total Metals

**Sample Name :** Method Blank  
**Lab Code :** K1507398-MB

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	Analysis Method	MRL	Date Analyzed	Sample Result	Result Notes
Antimony	200.8	0.005	07/14/15	ND	
Arsenic	7062	0.005	07/14/15	ND	
Barium	200.8	0.005	07/14/15	ND	
Lead	200.8	0.002	07/14/15	ND	
Mercury	245.1	0.001	07/15/15	ND	
Selenium	7742	0.005	07/15/15	ND	
Silver	200.8	0.002	07/14/15	ND	

Comments:

**ALS Group USA, Corp.**  
**dba ALS Environmental**

**QA/QC Report**

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** 07/07/15  
**Date Received :** 07/09/15  
**Date Extracted :** 07/10/15  
**Date Analyzed :** 07/14,15/15

Duplicate Summary  
Total Metals

**Sample Name :** JC Raff 3/6/2015  
**Lab Code :** K1507398-001D

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	Analysis Method	MRL	Sample Result	Duplicate Sample Result	Average	Relative Percent Difference	Result Notes
Antimony	200.8	0.005	ND	ND	ND	-	
Arsenic	7062	0.005	ND	ND	ND	-	
Barium	200.8	0.005	0.046	0.045	0.045	2	
Lead	200.8	0.002	0.005	0.005	0.005	<1	
Selenium	7742	0.005	0.050	0.040	0.045	22	
Silver	200.8	0.002	0.155	0.156	0.155	<1	

Comments:

ALS Group USA, Corp.  
dba ALS Enviromental

QA/QC Report

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** NA  
**Date Received :** NA  
**Date Extracted :** 07/15/15  
**Date Analyzed :** 07/15/15

Duplicate Summary  
Total Metals

**Sample Name :** Batch QC  
**Lab Code :** K1507267-001D

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	Analysis Method	MRL	Sample Result	Duplicate Sample Result	Average	Relative Percent Difference	Result Notes
Mercury	245.1	0.0002	ND	ND	ND	-	

Comments:

**ALS Group USA, Corp.**  
**dba ALS Environmental**

**QA/QC Report**

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** 07/07/15  
**Date Received :** 07/09/15  
**Date Extracted :** 07/10/15  
**Date Analyzed :** 07/14-29/15

Matrix Spike Summary  
Total Metals

**Sample Name :** JC Raff 3/6/2015  
**Lab Code :** K1507398-001S

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	MRL	Spike Level	Sample Result	Spiked Sample Result	Percent Recovery	ALS Percent	Result Notes
						Recovery Acceptance Limits	
Antimony	0.005	2.00	ND	2.07	104	70-130	
Arsenic	0.005	0.080	ND	0.091	114	75-125	
Barium	0.005	4.00	0.046	4.07	101	70-130	
Lead	0.002	2.00	0.005	1.68	84	70-130	
Selenium	0.01	0.080	0.050	0.123	91	75-125	
Silver	0.002	0.50	0.155	0.631	95	70-130	

Comments:

ALS Group USA, Corp.  
dba ALS Enviromental

QA/QC Report

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** NA  
**Date Received :** NA  
**Date Extracted :** 07/15/15  
**Date Analyzed :** 07/15/15

Matrix Spike Summary  
Total Metals

**Sample Name :** Batch QC  
**Lab Code :** K1507267-001S

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	MRL	Spike Level	Sample Result	Spiked Sample Result	Percent Recovery	ALS Percent	Result Notes
						Recovery Acceptance Limits	
Mercury	0.0002	0.0050	ND	0.0051	102	70-130	

Comments:

ALS Group USA, Corp.  
dba ALS Environmental

QA/QC Report

**Client :** Duke Hydro Chem  
**Project Name :** Gunnison  
**Project No. :** NA  
**Matrix :** Water

**Service Request :** K1507398  
**Date Collected :** NA  
**Date Received :** NA  
**Date Extracted :** 07/10-15/15  
**Date Analyzed :** 07/14,15/15

Laboratory Control Sample Summary  
Total Metals

**Sample Name :** Laboratory Control Sample  
**Lab Code :** K1507398-LCS

**Units :** mg/L (ppm)  
**Basis :** NA

Analyte	Analysis Method	True Value	Result	Percent	ALS Percent	Result
					Recovery Acceptance Limits	
Antimony	200.8	0.10	0.101	101	85-115	
Arsenic	7062	0.010	0.0120	120	80-120	
Barium	200.8	0.20	0.189	94	85-115	
Lead	200.8	0.10	0.0985	99	85-115	
Mercury	245.1	0.0050	0.00501	100	85-115	
Selenium	7742	0.010	0.009	91	80-120	
Silver	200.8	0.025	0.0253	101	85-115	

Comments:

## Technical Report for

### Excelsior Mining Corporation

#### Excelsior/Gunnison GW Testing

Accutest Job Number: C38189X

Sampling Date: 01/23/15

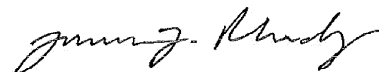
#### Report to:

Excelsior Mining Corporation  
2999 N. 44th Street Suite 300  
Phoenix, AZ 85018  
cbarnes@excelsiormining.com; LCandрева@haleyaldrich.com;  
KBlust@haleyaldrich.com  
ATTN: Curtis Barnes

Total number of pages in report: 8



Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Program and/or state specific certification programs as applicable.



**James J. Rhudy**  
Lab Director

**Client Service contact: Elvin Kumar 408-588-0200**

Certifications: CA (ELAP 2910) AK (UST-092) AZ (AZ0762) NV (CA00150) OR (CA300006) WA (C925)  
DoD ELAP (L-A-B L2242)

This report shall not be reproduced, except in its entirety, without the written approval of Accutest Laboratories.  
Test results relate only to samples analyzed.

Sample Summary

Excelsior Mining Corporation

Job No: C38189X

Excelsior/Gunnison GW Testing

Sample Number	Collected Date	Time By	Received	Matrix Code Type	Client Sample ID
C38189-1	01/23/15	09:30 KD	01/23/15	AQ Ground Water	012215



## Subcontract Chain of Custody

**Subcontract Lab: Radiation Safety Engineering, Inc.**
**Date Sent: 01/23/14**
**Date Due: Standard TAT**
**Project Name: EXLMCAZP6684 (C38189)**
**Project Location:**

Accutest Lab Number	Customer Sample Name/Field Point ID	Matrix	Method	Collect Date	Collect Time
C38189-1	012215	GW	Gross Alpha & Gross Beta  Radium 226 & Radium 228  Uranium:234/235/238-Isotopic (Total & Isotopic Uranium)	01/23/15	09:30

**Comments:** 1 x Gallon Container/Volume per sample

Samples dropped off by Kate Duke @ RSE, 01/23/15

Relinquished By: <i>Kate Duke</i>	Received By: Michelle. H	Date: 01/23/15	Time:
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

C38189

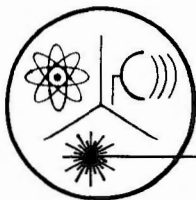
Client Information				Radiation Safety Engineering, Inc. 3245 North Washington Street Chandler, Arizona 85225											
Name <u>1</u>				Analysis Request											
Company <u>AccuTest</u>															
Address															
Phone															
PWS#															
Sampler Sig. Phone #				Drinking Water Compliance	Gross Alpha	Gross Beta	Total Uranium	Isotopic Uranium	Ra-226	Ra-228	H-3	Gamma Spectroscopy	Sr-89/Sr-90	Radon in Water	Radon in Air
Sample ID & Location (DWR#)	Collection Date Time		Media (DW* WW* Other)												
-1 012215	23 JAN 2015	0930			X	X	X	X	X	X					
Sample Receipt				Invoice to:				Relinquished by: <u>Kate Duke</u>							
Total No. of Containers			<u>1</u>					Signature							
Chain of Custody Seals			<u>1</u>					Printed Name <u>KATE DUKE</u>							
Container Condition			<u>good</u>					Company <u>DUKE HYDROCHEM</u>							
Lab No.								Date <u>23 JAN 2015</u>							
				Instructions/Comments				Received by: <u>Michelle Halvorson</u>							
								Signature							
								Printed Name <u>Michelle Halvorson</u>							
								Company <u>Radiation Safety Engineering, Inc.</u>							
								Date <u>1/23/15</u>							

u/client/forms/cofc.frm

\* DW = Drinking Water, WW = Waste Water.

Kate e duke hydrochem

## SUBCONTRACT DATA



## Radiation Safety Engineering, Inc.

3245 N. WASHINGTON ST. • CHANDLER, ARIZONA 85225-1121  
Website: [www.radsafe.com](http://www.radsafe.com)

(480) 897-9459  
FAX (480) 892-5446

### Radiochemical Activity in Water (pCi/L)

Accutest Laboratories  
2105 Lundy Avenue  
San Jose, CA 95131

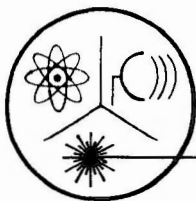
Sampling Date: January 23, 2015  
Sample Received: January 23, 2015  
Analysis Completed: February 09, 2015

Sample ID	Gross Alpha Activity Method EPA 900 (pCi/L)	Uranium Activity Method ASTM D6239 (pCi/L)	Adjusted Gross Alpha (pCi/L)	Gross Beta Activity Method 900.0 (pCi/L)	Radium 226 Activity Method 903.1 (pCi/L)	Radium 228 Activity Method 904 (pCi/L)	Total Radium (pCi/L)
C38189 012215	1046.6 ± 166.3	900.4 ± 33.1	146.2 ± 169.6	346.6 ± 42.0	< 0.7	< 1.3	< 1.3

Date of Analysis	1/30/2015	2/5/2015	2/5/2015	1/30/2015	1/24/2015	1/24/2015	1/24/2015
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Robert L. Metzger, Ph.D., C.H.P.

Laboratory License Number AZ0462



## Radiation Safety Engineering, Inc.

3245 N. WASHINGTON ST. • CHANDLER, ARIZONA 85225-1121  
Website: [www.radsafe.com](http://www.radsafe.com)

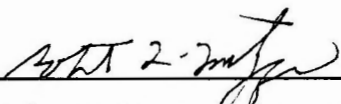
(480) 897-9459  
FAX (480) 892-5446

### Isotopic Uranium Analysis

Accutest Laboratories  
2105 Lundy Avenue  
San Jose, CA 95131

Sampling Date: January 23, 2015  
Sample Received: January 23, 2015  
Uranium Analysis Date: February 05, 2015

Sample No.	$^{238}\text{U}$	$^{235}\text{U}$	$^{234}\text{U}$	Total	
C38189 012215	430.2 ± 16.1	20.035 ± 0.115	450.2 ± 16.9	900.4 ± 33.1	Activity (pCi/L)
	1280.3 ± 48.0	9.362 ± 0.054	0.07238 ± 0.00271	1289.7 ± 48.1	Content (ug/L)
	Comments:				

  
Robert L. Metzger, Ph.D., C.H.P.

Laboratory License Number AZ0462

## Subcontract Chain of Custody

**Subcontract Lab: Radiation Safety Engineering, Inc.**
**Date Sent: 01/23/14**
**Date Due: Standard TAT**
**Project Name: EXLMCAZP6684 (C38189)**
**Project Location:**

51050

Accutest Lab Number	Customer Sample Name/Field Point ID	Matrix	Method	Collect Date	Collect Time
C38189-1	012215	GW	Gross Alpha & Gross Beta  Radium 226 & Radium 228  Uranium:234/235/238-Isotopic (Total & Isotopic Uranium)	01/23/15	09:30

**Comments:** 1 x Gallon Container/Volume per sample

Samples dropped off by Kate Duke @ RSE, 01/23/15

Relinquished By: <i>Kate Duke</i>	Received By: Michelle. H	Date: 01/23/15	Time:
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:



SGS North America Inc.

7701 N. Business Park Dr.

Tucson, AZ 85743

phone: 520.579.8315

fax: 520.579.7045

www.sgs.com

## Analysis Report Excelsior Mining Corp.

Project Number: M959-01A

Number of Samples: 1

Print Date: 01.26.15

Service Codes: A0002E30, A0001Be, A0001Se

Assay No.	Description	ICP Analysis														
		Ag	Al	As	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	La	Mg
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
78920	JC raff 012215	<1	7887	<1	<1	<1	470	4	19	1	8	135	<1	108	<1	6184
	Duplicate	<1	7885	<1	<1	<1	472	4	19	1	8	136	<1	108	<1	6181
	Method	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP
	Minimum Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Assay No.	Description	ICP Analysis														
		Mn	Mo	Na	Ni	P	Pb	Sb	Sc	Sr	Ti	Tl	V	W	Zn	Zr
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
78920	JC raff 012215	1092	<1	110	16	76	<1	<1	<1	<1	<1	4	<1	12	815	<1
	Duplicate	1092	<1	110	16	76	<1	<1	<1	<1	<1	4	<1	12	815	<1
	Method	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP
	Minimum Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Assay No.	Description	Analysis	
		Be	Se
		ppm	ppm
78920	JC raff 012215	4	<1
	Duplicate	4	<1
	Method	ICP	ICP
	Minimum Detection	1	1

Signature: \_\_\_\_\_

7701 N. Business Park Dr.  
Tucson, AZ 85743  
phone: 520.579.8315  
fax: 520.579.7045  
[www.metconresearch.com](http://www.metconresearch.com)

### Excelsior Mining

Metcon Project Number: M817-01  
Number of Samples: 1  
Print Date: 8.21.12  
Service Codes: A0002E30, A0001Su

Assay No.	Description		ICP Analysis	SO4=
			S	
			g/l	
58931	29485	Raff Solution	28.25	84.75
		Duplicate	28.75	86.25
		Method	ICP	
		Minimum Detection	0.01	

Signature: \_\_\_\_\_